REPORT RESUMES

ED 003 732 64
DESIGNING NEW APPARATUS FOR LEARNING.
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SOCIETY OF MOTION PICTURE AND TV ENGINEERS INC.
REPORT NUMBER NDEA-VIIB-045 PUB DATE 63
CONTRACT OEC-SAE-8758
EDRS PRICE MF-$0.36 HC-$10.04 251P.

DESCRIPTORS- CONFERENCES, *AUDIOVISUAL AIDS, *AUDIOVISUAL INSTRUCTION, *INSTRUCTIONAL TECHNOLOGY, PROJECTION EQUIPMENT, TEACHING MACHINES, PROGRAMED MATERIALS, FILMS, TELEVISION, PRINCETON, NEW JERSEY, NEW YORK CITY, NEW YORK

A 3-DAY CONFERENCE BROUGHT TOGETHER A GROUP OF SCIENTISTS, ENGINEERS, MANUFACTURERS, AND EDUCATORS TO DISCUSS THE STATUS OF AUDIOVISUAL EQUIPMENT AND THE KINDS OF NEW APPARATUS WHICH COULD BE DEVELOPED TO SERVE THE NEEDS OF EDUCATION. THE CONFEREES DISCUSSED SPECIFIC RESISTANCES TO INSTRUCTIONAL TECHNOLOGY AND THE VARIOUS EDUCATIONAL AND PSYCHOLOGICAL FACTORS WHICH IMPEDE THE DESIGN OF EFFECTIVE APPARATUS OF INSTRUCTION. IT WAS CONFIRMED THAT CURRENT KNOWLEDGE AND USE OF AUDIOVISUAL TECHNIQUES IN AMERICAN EDUCATION IS LOW AND THAT EVEN THE MOST PROGRESSIVE SCHOOLS ARE NOT ABLE TO MAKE THE KIND OF EFFECTIVE USE OF AUDIOVISUALS WHICH THE STATE-OF-THE-ART PERMITS. STILL-PROJECTION EQUIPMENT, TEACHING MACHINES AND PROGRAMING DEVICES, EIGHT-MM SOUND MOTION PICTURES, AND TELEVISION AND VIDEO-TAPE RECORDERS WERE DISCUSSED. (JH)

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DESIGNING NEW APPARATUS FOR LEARNING

ED003732

The project reported on in this publication was conducted at the request of, and under Contract #SAE-8758 with, the Office of Education, U.S. Department of Health, Education and Welfare.

The material in this publication was prepared under a contract with the United States Office of Education, as authorized under Title VII, Part B, of the National Defense Education Act of 1958. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy, and the manuscript has not been subjected to regular editorial review given Office of Education staff publications.

DESIGNING NEW APPARATUS FOR LEARNING

A Survey of Needs for, and Developments in, Audiovisual Devices Suitable for Educational Uses

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The survey and study reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education and Welfare.

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Library of Congress Catalog Card Number 63-21301

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FOREWORD

This publication stems from a conversation which one of the authors had back in 1959 with Dr. Roy M. Hall, at that time Assistant Commissioner for Research, U.S. Office of Education. It will be recalled that the recently enacted National Defense Education Act of 1958 was in the process of being implemented. Dr. Hall and his associates were seriously perturbed by some of the implications of the $25 billion school construction program which could then be foreseen as coming within the next few years. They worried lest architects, consulting engineers, school board members, school administrators, and the general public show no sign of making proper provisions in these new buildings to handle properly audiovisual media, including motion pictures and television.

In other words, we were in danger of the buildings being technologically obsolete even before completion. Once these edifices were built, the country -- if the past was any indication -- might have to live with them for as long as a century.

Because the USOE did not possess an engineering staff versed in the design and manufacture of audiovisual apparatus, need was expressed for a technically qualified analysis of the capabilities of the instructional equipment then on the market, as well as a "preview" of the kind of instructional hardware that might or could be specifically developed in the years to come to meet the needs of education.

It was felt that a survey of this sort would not only be helpful to those faced with designing new school buildings; it would -- even more importantly -- point a spotlight toward the path that must be followed if new educational media are to be brought into being to increase the quantity and improve the quality of American education.

The Services of a nationally respected engineering group would be helpful in outlining perimeters of the problem.

Prior to World War II, the Society of Motion Picture and Television Engineers -- in response to a request from the Committee on Scientific Aids to Learning of the National Research Council -- prepared in May 1941 a significant report entitled, "Recommended Procedure and Equipment Specifications for Educational 16-mm Projection." This report was instrumental in bringing about an appreciable industry-wide correlation of effort in the manufacture of 16mm projection equipment for the Armed Services.

On the basis of this patriotic precedent, it was felt that it would be helpful were the SMPTE to bring together a task force of scientists, engineers and manufacturers to discuss with a representative group of educators the status of present audiovisual equipment and the kinds of new apparatus which could be developed to serve better the needs of education.

Accordingly, it was decided that a three-day conference at a congenial location such as afforded at Princeton, New Jersey, would permit exploration of the subject through a fruitful interchange of ideas by educators and engineers alike.

It was recognized that the problem was much too vast to be solved or even properly defined at a single conference.

On the other hand, even if only a beginning could be made, this, of itself, might serve to point the way to an ultimate solution to a vital problem.

American education is so extensive and so diverse that it is impossible to find any one person or small group of individuals who can rightfully claim to voice fully the needs of education and to define them in terms of maximum helpfulness for the educational media equipment manufacturers.

Likewise, among scientists, engineers and manufacturers involved in this field, it is manifestly impossible to find any small group of individuals qualified to represent the entire audiovisual equipment industry.

Of necessity, a compromise was called for.

In selecting members of the Conference, a sincere effort was made to pick a representative cross-section of educators and engineers.

It was felt that the Conference ought to be limited to not more than 34 individuals, in order to permit discussion by the group as a whole and to obviate the necessity of breaking down into smaller discussion groups.

A number of members of the Society and non-SMPTE individuals in the audiovisual field expressed interest in the Conference and, in person and in writing, generously volunteered their services as conferees. Unfortunately, the limitations of the occasion made it impractical to take advantage of a number of these offers.

In picking participants to represent the field of education, we tried to secure adequate representation for the following specific areas of interest:

- AV practice
- Educational television
- Psychology of learning
- School administrators
- Teacher training
- Curriculum
- Textbook publishing
- Educational methods
- Teacher and cross media approach
- University administration
- Creativity

In choosing experts to represent science, engineering, equipment manufacturing, and equipment marketing, it was felt that the following fields of interest should be represented:

- Electronics
- Chemistry
- Illuminating engineering
- Mechanical engineering
- Audiovisual engineering
- Marketing
- Manufacturing
- Systems methods
- Large manufacturers
- Small manufacturers
- Audiovisual equipment dealers

The Conference was held June 4-7, 1961, at the Princeton Inn, Princeton, New Jersey. Individual participants were invited to prepare background papers prior to the Conference. Each participant was provided with a large notebook containing copies of these papers and numerous other documents designed to furnish him with background information about the problems to be discussed.

The entire Conference was recorded by a court stenotypist. The transcript, which came to nearly 700 pages, was a weighty volume.

To boil it down to manageable size, while still retaining the substance of the Conference discussions, proved to be a formidable task. Messrs. Allen and Flory went into this material, arranged it in more orderly form, and prepared a greatly condensed version. This document was subsequently circulated to all those who had originally attended the Conference. Their changes, deletions, and additions were, wherever possible, taken into consideration when making the next revision.

The present version has tried to take into account objections or suggestions by individual participants. Where a point has had to be arbitrated, the project director assumed the responsibility of making a final decision. Thus, it is only fair to say that things of merit in this study should be attributed to the Conference participants; unsatisfactory points are the responsibility of the project director.

Because so many persons contributed to this joint effort, the style, of necessity, is not entirely uniform. The reader who has the patience to read the book, however, will be rewarded we think by obtaining an insight into the many hurdles that must be overcome in order to bring to the education of our children and to their children in turn the full fruits of the scientific age in which they are going to be living.

In an effort to be helpful, we have broken up the text with more than the usual number of explanatory headings. In addition, a complete table of contents and an index have been provided for those who wish to use this as a reference work.

All of us who participated in the Conference recognize that the problem of obtaining better and more functional instructional apparatus is so complicated that no group meeting together for a comparatively short time can adequately delineate the problem, let alone hope to suggest ultimate solutions.

On the other hand, because such answers will come from many quarters of the educational field; from scientists, engineers, manufacturers, communication specialists, psychologists, Government officials, textbook publishers, audiovisual materials producers, systems experts, classroom teachers: yes, and from students too -- it takes a varigated, carefully structured group such as was assembled at Princeton to preview the problem with collective objectivity.

Because such a competent, comprehensively chosen panel had never before been assembled to consider the audiovisual apparatus problem, we commend the Conference proceedings to you. If they stimulate further thoughts on new instructional media, the effort will have been justified.

John Flory
William H. Allen

Rochester, New York
and
Pasadena, California

July, 1963

ACKNOWLEDGMENTS

This study is the result of much unselfish work on the part of many people.

Unfortunately, space does not permit proper acknowledgment to all those both within the Society and the rest of the field who offered helpful suggestions as to the nature and structure of the investigation.

The Society wishes to thank the Conference participants for their deep interest in this project, as evidenced by their helpfulness in preparing background papers, coming to the sessions at Princeton, and criticizing the draft manuscript of this book.

Dr. Chandos Reid Rice and the Association for Supervision and Curriculum Development deserve thanks for their assistance in correlating this project with their own research contracts dealing with the new educational media. Dr. Randall Whaley offered helpful suggestions for the design of the project, as did Dr. Deane R. White and Dr. Calvin Taylor. Others who contributed valuable counsel included Messrs. Fred A. Aufhauser, Peter Gartland, Wilton R. Holm, Donald E. Hyndman, Ethan M. Stifle, Adrian L. TerLouw, and Gordon H. Tubbs.

We of SMPTE wish to thank the members of the staff of the New Media Branch of the U.S. Office of Education for their help and guidance throughout the period that this project was being conducted; in particular, the following individuals successively: Drs. Roy M. Hall, C. Walter Stone, Seth Spaulding, and Thomas Clemens.

In the same vein, I wish to express my own appreciation to the officers, Executive Committee, Board of Governors, and main office staff of the SMPTE for their invaluable guidance; to Col. Charles S. Stodter, executive secretary of the Society, who at every step of the way has been an unfailingly patient and helpful mentor; to Dr. Norwood L. Simmons and Mr. John W. Servies, past presidents of the Society, and to Mr. Reid H. Ray, the current president, for their sympathetic interest in the aims and objectives of this endeavor.

To my co-author Dr. William H. Allen, should go credit for having borne the brunt of the writing effort involved in translating the verbatim transcript of the proceedings into a more succinct and coherent manuscript. Conscientious stenotype reporting was performed by Mr. George A. Sakson of John F. Trainor, Inc.; charts and diagrams were drawn by Mr. Richard Burandt; proofreading assistance and the compilation of the Index were done by Mr. Leonard Steinberg; Messrs. Victor H. Allen and John W. McFarlane provided sage editorial counsel; and editorial supervision was graciously accorded by Messrs. Glenn E. Matthews and Herbert E. Farmer, respectively past and present SMPTE editorial vice-presidents.

Mr. Thomas W. Hope volunteered invaluable assistance in connection with Conference arrangements.

To Mrs. David Curtis goes my deep appreciation for handling all the secretarial facets of the enterprise including preparation of the manuscript. Thanks are likewise extended to the Misses Lois Gauch and Patricia Rutan, and to Mrs. Betty Clark and staff.

In another, but very real sense, I owe gratitude to both my wife, Bee, and son, Jack, for their good-natured patience during the prolonged time that I was so involved in this project.

And finally, I wish to thank publicly the Eastman Kodak Company, my employer, and Mr. G. W. Mentch, my immediate superior, for their generosity in permitting me to take off such time from my regular duties as was necessary to conduct this professional activity of the Society of Motion Picture and Television Engineers on behalf of the U.S. Office of Education. Needless to say, the contents of this report may or may not necessarily reflect the views of Kodak, the USOE, or the SMPTE itself; they are those of the Conference participants conscientiously but perforce imperfectly edited.

John Flory
Project Director

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PART ONE

A SUMMARY OF THE CONFERENCE

Chapter 1.

AN "OVERVIEW"

(What This Book Is All About)

Here, in essence, are the principal conclusions of the Conference:

Crisis in Education

American education is in violent ferment. Concurrently, four explosive influences are at work:

1. The population explosion.

   A bumper crop of students is overtaxing the nation's school facilities. Maintaining and improving the quality of general education in the face of this increase in the number of pupils is a major problem.

2. The knowledge explosion.

   Modern, more scientific methods of scholarship are drastically changing the content of even traditional subject areas. In addition, the rate at which human knowledge is expanding in the field of science means that there is hardly a segment of the school curriculum which is not undergoing drastic change.

3. The psychology-of-learning explosion.

   Recent advances in psychology are having, and will have, great influence on our future approach to the teaching-learning process. Progress in numerous scientific disciplines indicates that man is on the threshold of learning how the mind itself works. Efforts in this direction are already affecting teaching methodology.

4. The instructional technology explosion.

   The whole complex of new audiovisual tools and techniques offers exciting vistas for improvement in the teaching and learning process. At the moment, however, the introduction of these "power tools to learning" is forcing basic re-evaluation of curriculum presentation.

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A New Type of Education for a New Era

It was in the context of the foregoing conditions that the Princeton Conference met to examine the suitability of present-day audiovisual apparatus and to recommend the means by which more appropriate systems can be developed to serve the future needs of education.

Toward an Instructional Technology

There is little doubt that American education is on the verge of an amazing breakthrough in the matter of tools of instruction. During the past 30 years, there has been a quickening growth in instructional technology. It is clear that this technology must satisfy the needs not only of traditional-sized groups of students, but also of large groups and of the individual student.

The greatest challenge facing it is to find a way to mass produce quality education, tailor-made to the needs and abilities of each particular student. This means finding methods not only of handling rote instruction, but also of inculcating in the student self-reliance in solving problems and of encouraging his creativity.

Current Status of U.S. Audiovisual Instruction

Analysis of the present use of audiovisual techniques in American education indicates that a small percentage of advanced communities makes considerably more use of them than do schools as a whole.

Because today's audiovisual apparatus has evolved piecemeal, even the most progressive of schools are not able to make the kind of effective use of audiovisuals which the state of the art permits.

Resistances to Instructional Technology

The Conference considered the reasons why the audiovisual movement has encountered resistance: cultural lag, economic factors, ignorance of audiovisual techniques, difficulties in "breaking the habit barrier" (teachers tend to teach as they themselves were taught, insufficient released time for in-service training of teachers in the use of audiovisual methods, lack of equipment, inefficient equipment, overzealous promotion of AV, uncorrelated types of apparatus, deficiently designed school-buildings, teachers' fear of replacement by machines, a print-oriented, literary tradition -- all these were cited as roadblocks that have held back greater use of audiovisuals.

Certain Educational and Psychological Considerations

The kind of apparatus called for by an instructional technology must meet teacher-learner needs. It must encourage a high level of teaching. Recognition must be given to the importance of the student's social attitudes, the differences in levels of motivation among students, the factors of physical and mental growth, and to other sound educational considerations.

This matter of fostering student motivation to learn is too often neglected in traditional teaching. If the new tools for learning can stimulate pupil motivation, they will work wonders in education.

Likewise, in the design of audiovisual apparatus -- and particularly of programs for use with such apparatus -- every effort should be made to create devices and systems that will foster student creativity.

Ten psychological factors were described as strongly influencing the design of effective apparatus of instruction. Thus, educational and psychological considerations not only shape the design of apparatus; they also determine the form of the instructional environment as well as the other conditions of learning in which the apparatus will be used.

What Are the Categories of Audiovisual Equipment?

There are at least 200 distinct types of audiovisual media. Because of this large number, the following selection was deemed to be of particular significance:

> Motion pictures, motion picture production,* television, filmstrips, slides, overhead projectors, opaque projectors, tachistoscopes, reading accelerators, microfilm and microprint storage systems, radio, telephone, record-players, tape-recorders and reproducers, learning (language) laboratories with visual and auditory capability, still photographic production, three-dimensional display devices, multiple-screen display systems, electronic computers, teaching machines, simulators.

Access to Instructional Material

In the process of making use of instructional content, the instructional information is stored in some accessible form. It is retrieved by some means. And it is finally displayed to the student.

The best known systems for storage of information are: print, photographic, plastic, magnetic, crystal or ferroelectric, electrostatic, phosphor-luminescent storage, scotophor storage, mechanical, electric circuits having two states, biological storage.

Retrieval and distribution of information were accorded much attention by the Conference. The relative merits of electronic versus mechanical display systems were debated. Some participants felt that closed-circuit television is an ideal way to distribute motion pictures into the individual classroom. Others felt that cost factors and the present imperfect state of the art make mechanical methods of distribution, such as by 8mm sound film, more practical. It was agreed that much further investigation of comparative costs and feasibility is needed.

---

*Here the act of producing a motion picture by students -- with or without teacher help -- becomes a learning experience per se. In such context motion picture production is defined as a medium.

Display of information is conditioned by audience requirements, light control in classrooms, and sources of projection light. The experts foretold significant improvement in projection lamps for motion picture and slide projectors within the next few years. These better light sources will bring about smaller, more convenient, more efficient projectors. It was predicted that future 8mm motion picture projectors will be capable of throwing a better picture on the screen than do today's 16mm machines. Similarly, substantial improvements are predicted for television.

Status of Still Projection Equipment

The opaque projector was analyzed. Feelings seemed to be that either it will diminish in importance or it must undergo a radical improvement in design.

Present disadvantages in overhead transparency projectors were considered, in view of the growing popularity of this device. Specific design improvements were recommended.

2" x 2" slide projectors have not achieved the wide acceptance in elementary and secondary schools that they have in the amateur market or in industrial applications. "Automatic" remote-control slide projectors now offer new possibilities in education. Before 2" x 2" color slides can come into their own, however, manufacturers must come up with easier answers to the problem of converting photographs and drawn art work to slides and filmstrips by some sort of on-the-spot, convenient "dry-photographic" process. It was pointed out that filmstrips are probably the most widely used type of projected material.

Teaching Machines and Programmed Learning

Since teaching machines and programmed learning were the subject of separate United States Office of Education contract groups, this conference did not devote the time to them that otherwise would have been justified.

At the moment, the big problem lies in preparing the "programs" for programmed learning. Essentially, this is a writing and publishing problem, and it is proving to be a costly and massive undertaking.

It was felt that ultimately some type of microfilm may be the most economical format in which to disseminate individual copies of teaching machine programs, because in their present form the latter bulk much larger than courses of study prepared in normal printed paper form.

Before equipment manufacturers can produce teaching machines of reasonable quality at reasonable prices the field will have to agree upon a few types of units as standard.

8mm Sound Motion Pictures

For the educator, the advent of 8mm sound film may some day prove to have been one of the most important motion picture innovations of the past 25 years.

With 8mm, motion pictures need no longer remain a large-group medium. Now small-group or even individual-student viewing becomes feasible. While marketing 8mm release prints for classroom use is today economically impractical, there are individuals who see in 8mm an ultimate answer to the need for lower cost prints for the schools -- if, by means of this smaller gauge product, a greatly increased mass market for prints can be developed.

In addition, it is felt by some that 8mm sound film will open up exciting new chances for local film production -- by teachers and students alike.

One of the most aggravating problems that has beset educational motion pictures has been that of achieving a simple, foolproof method of threading the film into the projector. Now 8mm may offer the way to solve this hurdle to greater film usage.

The relative merits of slot loading versus magazine, or cartridge loading were examined, with the preponderance of opinion favoring the former as being the easier solution.

At present, however, release-printing of 8mm film is in a somewhat exploratory stage. It is the hope of 8mm sound-film advocates that inexpensive, light-weight, automatic-threading projectors will eventually find a market in nearly every classroom.

In short, it is hoped that 8mm sound film will prove the means of opening up a vast, new mass market for teaching films. In motion pictures, it is predicted, 8mm sound film will bring about a revolution comparable to that which the paperback book sparked in the field of book publishing.

Television and Video-Tape Recording

It was pointed out that -- at least in colleges and universities -- the press of rising enrollments, combined with a dearth of faculty, will make imperative the use of some means of automated instruction in handling large groups of students. Because the so-called lecture system is more prevalent in higher education than in elementary and secondary schools, there is a present tendency at the college level to use both open-and closed-circuit television to meet this problem.

Although the reliability of educational television (ETV) systems for mass-audience use is adequate, it needs to be improved upon in order to reduce costs of operation and maintenance of modest-size installations.

Improved TV cameras, distribution systems, switching apparatus, and classroom receivers are needed. Talk-back, or individual-response, stations were highly recommended as a valuable teaching adjunct to closed-circuit TV installations.

It was hoped that inexpensive (in the neighborhood of $500) video-tape recording and playback equipment will eventually be available for schools, but the consensus of the engineers present was that it was still too soon to predict a timetable for the perfection of such items.

Establishing Equipment Standards

The Conference recognized that this is a most critical time in the development of the apparatus of instructional technology. Furthermore, it agreed that there is need to establish some basic standards of performance and quality for newly developed devices.

Where standards are set up, they are always interchangeability standards. They are never quality standards.

Precedents in other fields were discussed to see whether they might suggest a solution for the audiovisual field.

The role of the American Standards Association was delineated, as it might relate to activities of such organizations as the U.S. Office of Education, the Society of Motion Picture and Television Engineers, the Department of Audiovisual Instruction of the National Education Association, or some especially constituted industry-wide cooperative group.

It was felt that the United States Office of Education, in cooperation with one or more of the interested professional groups, might assume the initiatory role of proposing certain needed performance standards covering audiovisual apparatus.

Determining Functional Specifications

Educators should encourage the seeking of technological solutions to their teaching problems. A "strategy of design" is called for. This means the establishment of closer liaison from the very outset between educators and equipment makers. The matter of the quality of a piece of apparatus needed to achieve a predetermined educational objective as related to the cost, is a factor.

Technical Quality: Film vs. Television

As a concrete example, the matter of television image quality versus that of the motion picture was discussed at some length.

In this case, it was felt by some (not all) that the present commercial 525-line television standard is a definite limitation on the effectiveness of live television as an instructional medium. The quality of the image is probably adequate in situations where students are watching a very generalized event -- such as a re-enactment of history -- but may not be what is needed if the student must observe a map or similar subject in which very fine detail is important. The fact that color television is not yet widely installed is a drawback when teaching certain subjects by television.

When compared to 16mm film, the maximum resolution of television (525-line 4.5 megacycles) is inferior, and it is about equal to 8mm film today.

There are 1200-line (and for special purposes even some 2000-line) television systems available which could be used for closed-circuit ETV installations. The drawback is their high cost.

When some 15 years ago a committee of the SMPTE measured the amount of information on a 35mm theater screen, it found it to be on the order of 25 megacycles. Better films, laboratory techniques, and equipment have improved this result by a large factor in recent years. The typical commercial television installation, in contrast, is probably between 2 and 3 megacycles.

How Important Is Quality in AV Equipment?

There is no question about our need for high-quality education. Nor is there a question about the want of equipment that will stand up, under repeated use, with dependability. On the other hand, the question may be asked as to the level of technical excellence needed in the communication carrier itself.

No conclusions were reached on this technical moot point. The engineers tended to favor high standards of technical quality. The educators expressed reservations as to the need for extremely high quality, yet favored attempts to design for an optimum rather than for the lowest tolerable standard of quality.

It was subsequently pointed out by one manufacturer's representative that procurement practices of educational institutions in general are a serious deterrent to manufacturers developing and marketing new educationally oriented equipment or equipment of a quality beyond that required by the lay, mass market. Many "blue sky" pilot models have been planned by industry, but cannot be marketed economically to the education field alone on the basis of small purchases.

How Best Can We Encourage Development of New Audiovisual Apparatus?

Should instructional equipment be developed with the assistance of governmental subsidy? What kind of education-industry cooperation in the development of these devices is needed?

Some of the participants who represented manufacturers said that their companies would prefer to develop, manufacture, and market new audiovisual equipment without assistance from government.

In the course of discussion, it was brought out that governmental subsidy of new-product development often entails new patents becoming the property of the government, not of the contractor. Unlike the creation of military items of hardware for which there are limited civilian markets, the development of audiovisual equipment with Federal subsidy could very easily place the U. S. government and the contractor in direct conflict with each other in serving the educational market.

The educators participating in the Conference tended to favor some form of governmental underwriting, to hasten the advent of radically new apparatus as well as items for which there would admittedly never be profitable sales.

The Conference reached no decision on this controversial point. It was generally conceded that what we may need is a new technique for speeding an innovative idea to a stage where it can be marketed. It was agreed that greater cooperation between education and industry would be of mutual benefit. Educators must learn to describe their needs in technological terms. Manufacturers, in turn, must pay closer attention to educational needs and specifications.

A Systems Approach to Education

Most of our instructional materials are produced as separate and distinct communications, having too frequently but superficial relevance to the real objectives of education or teaching needs.

Now, however, there are signs that commercial producers of instructional materials are beginning to explore the salability of "packages" -- simple systems of materials. Language laboratories were cited as examples of commercial attempts to provide in one package a system of apparatus designed to perform a specific curriculum job.

The difficulties encountered in combining such diverse pieces of equipment as record players, tape recorders, and motion picture, filmstrip, and slide projectors, into an efficient and integrated system prove that we must find a new approach to the creation of an instructional system.

To the educator falls the responsibility of specifying educational requirements in terms of pupil needs and instructional problems.

To the supplier of equipment falls the task of designing, manufacturing, and marketing the needed apparatus.

To a new member of the team, the systems man, then falls the assignment of matching equipment capability to the teaching needs. He, by background and training, is able to translate the educator's needs into terms that make engineering and economic sense to the equipment manufacturer. This kind of feat the systems man has performed successfully many times in both the military and the data-processing fields.

What we now need is a professional breed of highly competent, teaching-learning systems experts.

Approaches to Equipment Design

Too much of the present audiovisual equipment is complicated, and it exists in bewildering variety. Such proliferation of devices often makes the instructional job of the teacher and school administrator more difficult.

Perhaps there needs to be standardization on fewer devices.

Greater thought must be given to creating systems of apparatus that will bring out student creativity.

Offered provisionally as a background paper for the Conference was a check list of some of the desirable capabilities which any ultimate teaching-learning systems approach to education will demand of the apparatus.

What the Future Could Bring

One idealized system would link individual TV screens at the teacher's and pupils' desks with large, wall TV screens. Picture images would be in color and have far higher definition than is commercially available today. Sound would be high-fidelity. Complete flexibility would let the teacher choose from a wide assortment of program material and direct to each student the same or individual message content, as needed.

This classroom system would also be connected with outside transmission sources -- such as closed-circuit or over-the-air telecasts, or the output of computer-indexed reference libraries of documents, books, pictures, maps, tapes, motion pictures, etc. Into the classroom system, the teacher and pupils would be able to transmit material presented on slides, filmstrips, transparencies, movies, as well as live action. Through a perfected process of immediate "dry-photography", students and teacher would be able to reproduce full-size "hard copies" of any images shown on the screen.

Likewise, an integral feature of the system would be its linkage with a computer center, so that individual viewing stations could, when expedient, function as teaching machines for formal study or exams.

Flexible versions of such a system would provide each student with a personal, two-way pocket-size TV transmitter-receiver.

Recognizing that the foregoing system is still Utopian, the Conference nonetheless urged a thorough trial, under all kinds of school conditions, of the systems approach to the teaching-learning process.

By using a philosophy of modular design for the system's components, the instructional systems method could be put into use with apparatus either now in existence or still being researched by manufacturers. Then, as new and more highly perfected apparatus gradually becomes available, it could be substituted for the less efficient earlier components.

Brainstorming "Cloud-Nine" Apparatus

Audiovisual apparatus has up until now been developed in too haphazard and pedestrian a way, it was the consensus of the Conference.

More imagination should be applied to creating devices to speed up and improve the teaching-learning process.

To make this point, Conference participants "brainstormed" ideas for needed new equipment, came up with a lengthy want list in but a matter of minutes. A provocative dozen:

** "Invisible wall" study nooks ultrasonically isolated against distractions

** Easier movie film threading

** Vest-pocket microfilm readers

** 8mm filmstrip projectors

** Light-amplifying projection screens

** Computers that would encourage creativity in pupils

** Desk-top and classroom-wall TV viewing screens

** "Instant" movies from cigarette pack cameras

** Personalized, repeating TV sets to play back programs

** Vast reference libraries automated and shrunk to desk size

** Feature-length films contained on a postcard

** Electronic blackboards on which you write by thinking

The Space Age Challenge to American Education

Not since the founding of the Republic has the United States so needed to take stock of the kind of education it should provide for its citizens. Our national survival during the century to come may depend on every citizen's becoming educated as fully as his innate intellectual capacity permits.

In the underdeveloped areas of the rest of the world, over a billion human beings are clamoring to participate in the rewards of industrialization. America is faced with the prospect of decades of military and economic competition.

A look at the record will reveal that historically the American educational system has performed magnificently. Yet this system today -- in the light of tomorrow's demands -- is technologically obsolete.

Somehow, we must devise for the teaching profession "power-tools for learning." Teachers must some day be helped in their task as are certain members of the medical profession who are backed by a team of assistants, and be provided with the equipment to increase the individual practitioner's efficiency and output.

American education is undergoing a fourfold revolution -- in how we think we learn, in a tidal wave of students, in subject-matter content, and in new instructional apparatus.

First order of business is to dispel the chaos of the audiovisual equipment field.

Recommendations

The USOE-SMPTE Conference on Audio-Visual Apparatus came forth with some 44 recommendations. In effect, these stated:

To Achieve Cooperation across a Wide Field:

Methods are needed for closer industry-education cooperation, as well as more cooperation among educators themselves, AV groups, users and suppliers, business and armed service AV users.

There should be wider publicity for needed apparatus -- a national AV "want list".

Research and Development and Field-test Programs:

U. S. government contracts for field-test demonstrations?

Scientific research into equipment, into media effectiveness.

Regional audiovisual research centers were endorsed and proving grounds on elementary, secondary, and college levels.

Industry urged to provide consultative AV services to education, to architects and school building officials.

Certain Implications of Research on Devices:

Performance standards for AV equipment should be established. Designs should incorporate simpler, modular parts.

How do we uncover equipment wants? Avoid ill-conceived standardization?

Varying audience sizes: Differences in design.

Types of New Devices Being Called for:

To lighten teachers' "housekeeping" chores; to assist self-study by adults; for use by individual students.

Information-storage-and-retrieval systems for school libraries; more 8mm sound editions of classroom films; apparatus to stimulate student creativity.

Simpler AV tools for the underdeveloped countries ... closer ties with space age technologies.

A Systems Approach to the Teaching-Learning Process:

Full probing of "systems approach" concept ..., via a U.S. government contract.

Making use of computers to help train school administrators... interrelationship of book and film libraries ... in-service training of teachers to handle instructional systems.

A new profession -- the teaching-learning systems specialist.

Bringing hope to the public ... the proper role of AV.

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PART TWO

BACKGROUND OF THE PROBLEM

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Chapter 2.

THE CRISIS FACED BY AMERICAN EDUCATION

The United States -- many of its natural resources rapidly becoming depleted -- finds itself faced with the prospect of being a "have-not" nation. How then can it survive as a first-rate power during the next century in competition with both an industrialized Orient and Latin America?

Education Vital to National Survival

One penetrating study* points out that our most valuable national asset is actually the American people -- their intelligence, imagination, energy, training, drive, initiative, and ability to maintain the kind of life that they feel is worth having. Thus, our survival as a first-class power may well depend upon the kind of education we give our children during the next decade or so.

This then means that every U.S. citizen should be educated to the full extent of his ability to profit from a fine education.

Advances in science will provide substitute foods, materials, and energy sources. These, however, can only be fully attained by a highly competent and educated citizenry. From now on, education is, as never before, crucial to America's national survival.

Crisis in Education

As a result of this crisis, American education is in violent ferment. Members of this Conference recognized the need to identify and to understand other revolutionary factors that are having a profound effect upon education at the present time; four different ones served as background for these discussions:

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*Harrison Brown, James Bonner, John Weir, The Next Hundred Years. (New York, The Viking Press, Inc., 1957).

1. The population explosion.
2. The explosive growth of knowledge.
3. The revolution in science and technology.
4. The breakthrough in psychology.

The Population Explosion

The current rapid growth of the population of the United States threatens to outstrip the expansion of educational facilities needed by our young people. One population estimate for 1980 is 240 million people, creating conditions of existence that are beyond our comprehension. Such growth will bring with it geographical shifts of masses of people, thereby creating new regional groupings and concentrations of population that will in turn result in new educational responsibilities and techniques of management and instruction.

The Explosive Growth of Knowledge

We are going through a period in which new knowledge in almost every field, especially the sciences, is increasing at an exponential rate. This has led to increased specialization by most professional scientists, putting additional burdens upon the educational system. The storage and retrieval of the printed record of this knowledge is becoming one of our most urgent communication problems. Some 2,000 printed pages of new material on science and technology are being published every minute of every day, and more than 1,250,000 articles of a scientific and technical nature are being published yearly.

The Revolution in Science and Technology

This explosive growth of knowledge has been accompanied by a simultaneous revolution in technology. Thus, research and development are now considered to be basic requisites to progress, in fact to survival. This technological change results in a demand for revitalization of education and of instructional techniques in order to keep up with these changes, and to educate our manpower for the new vocations that are developing. The impact of advances is being clearly reflected in a surge to apply technological developments to the process of education itself.

The Breakthrough in Psychology

Finally, we are engaged in a process of discovering how human beings learn; we are learning about learning itself. This concern with the psychology of learning and the mechanisms of creativity is casting light on all phases of teaching methodology.

A New Shape to Education

These four revolutions place a burden upon educators and upon the designers of instructional apparatus and materials to shape the educational system and the tools of learning to the needs of today and of the future. A beginning is being made in the development of a concept of instructional technology.

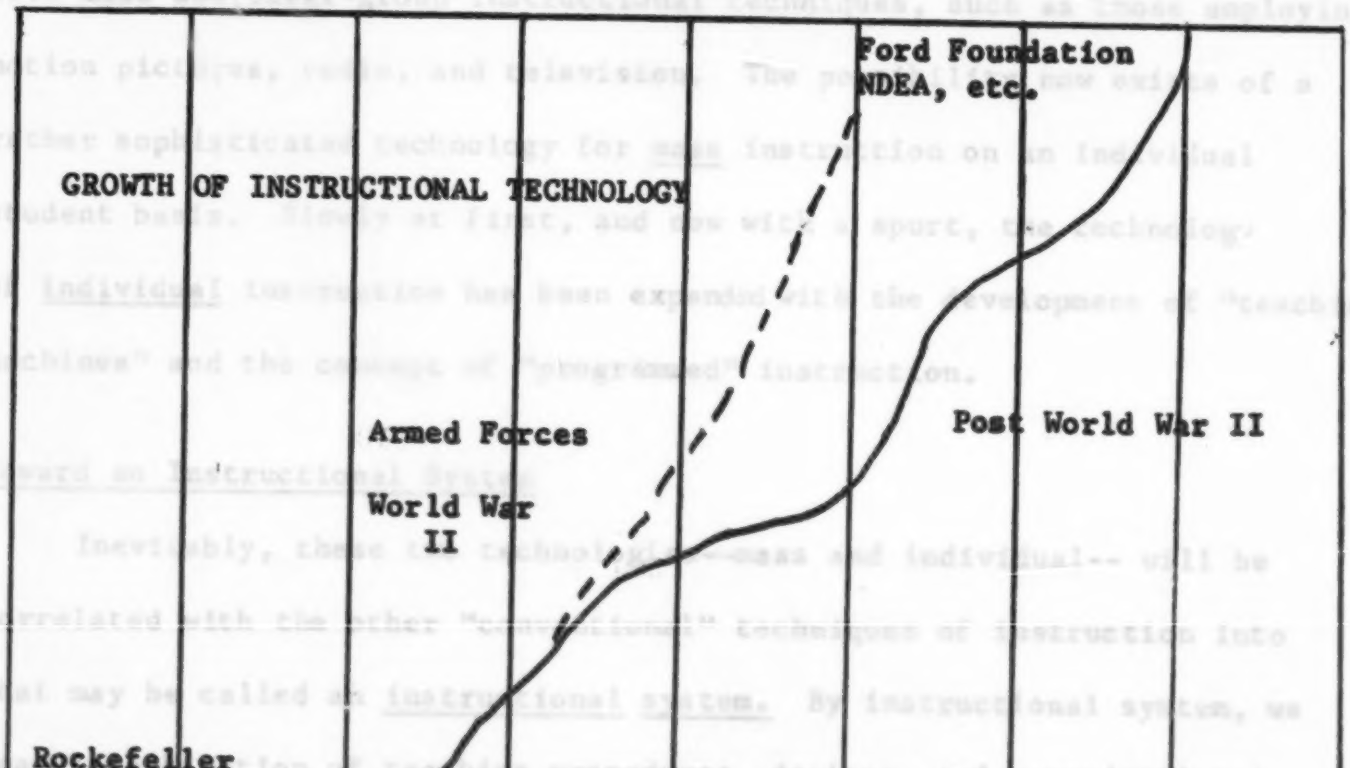
Chapter 3.

A CONCEPT OF INSTRUCTIONAL TECHNOLOGY

American education may well be entering a new era -- an era marked by a technological revolution in the tools of instruction. The signs of this change can already be read -- in the educational applications of television, language laboratories, teaching machines, and instructional systems. To be sure, these innovations have not yet permeated the mainstream of American education, but there is every reason to believe that our schools cannot long resist the force of technological change.

The Growth of Instructional Technology

The growth of this instructional technology was described by James Finn, who pointed out, using the following graph, the impetus that has been given to audiovisual education during the past 30 years.



The chart shows that, until the mid-1930's, the introduction of audiovisual materials and devices into education was a slow process. Then the infusion of foundation money, the attention given to the field by a group of talented men, and the availability of better materials and machines contributed to a rise in the use of these new teaching aids. During World War II, audiovisual technology made rapid progress in military and industrial training; and, following the war, public interest in these instructional techniques caused an upsurge in their use in the schools. Finally, since 1955, stimulated by television, the influx of Ford Foundation support, the National Defense Education Act, and similar efforts, the curve of instructional technology development has again started up sharply. We are at present in the full flowering of this growth.

Mass and Individual Instruction

The first technological developments in education were those associated with mass and large-group instructional techniques, such as those employing motion pictures, radio, and television. The possibility now exists of a rather sophisticated technology for mass instruction on an individual student basis. Slowly at first, and now with a spurt, the technology of individual instruction has been expanded with the development of "teaching machines" and the concept of "programmed" instruction.

Toward an Instructional System

Inevitably, these two technologies--mass and individual-- will be correlated with the other "conventional" techniques of instruction into what may be called an instructional system. By instructional system, we mean a combination of teaching procedures, devices, and organizational groupings that are designed to meet in an optimal way the educational objectives, in relation to content and the needs of individual students.

The development of such systems of instruction -- having the capability of increasing educational productivity by making best use of the tools of instruction -- is, the Conference participants felt, an important goal. It was to the realization of such a potential that this conference directed much attention.

Chapter 4.

AUDIOVISUAL INSTRUCTION IN AMERICAN SCHOOLS TODAY

Despite increasing attention by educators to the potentialities of instructional systems, we can point to no full-scale examples of such programs in action. Neither can we specify an audiovisual program in any single school and say, "This is typical of audiovisual instruction in American education."

On the contrary, current U. S. audiovisual programs range from the bare minimum of a chalkboard and bulletin board to schools that do use a gamut of technological tools, including television and teaching machines. Even where a wide assortment of audiovisual apparatus is regularly used, however, this equipment is not normally employed as a system, as hereinafter in this report defined.

Textbooks As Well As Apparatus

Such a state should not be blamed on the individual school district. Rather it is because a teaching-learning systems approach to education is, as innovations in this field go, a relatively new concept. Before a valid systems approach can be devised, the whole role of the textbook will have to be re-evaluated in relationship to audiovisual media and teaching machines.

Because this particular conference was convoked for the express purpose of treating with "audiovisual devices for educational use," the medium of the textbook was not itself featured. The tremendous contribution which the book has made, and will continue to make, in instruction was recognized by all those present. Had time permitted

they would have welcomed a chance to take up in detail a consideration of the interesting relationships which the next decade will see evolve between textbooks, audiovisual materials, and programmed learning. All of these appear destined to be synthesized into a unified systems approach to the teaching-learning problem.

What Is An Optimum Audiovisual Program Today?

Meanwhile, to understand the potentialities of audiovisual apparatus, we must first learn what an optimum AV program is today. Although there may be no one typical program, there are examples of intelligent applications of apparatus and techniques available. The conferees needed a glimpse of the present state of the art in order to have a common ground of experience at the Conference on which to make recommendations for an instructional technology of the future.

Analysis of Usage by a Progressive School System

Penfield Central School District #1, in upstate Monroe County, New York, met this requirement. This is a suburban district with one high school, one junior high school, and four elementary schools. It has an excellent, young teaching staff and an administration and school board that recognize the contributions audiovisual materials can make to improving instruction.

For the purposes of this Conference, therefore, James Meagher, Penfield coordinator of audiovisual instructional materials, presented an illustrated slide talk describing his school system's AV program.

Selected comments on Penfield's experience with the various media are here touched upon in brief verbatim excerpts:

Hook and loop boards

> "...an improvement over the traditional flannel boards and magnetic boards...more versatile."

Leaf boards

> "This elaborate version of the chalkboard is still a favorite with many teachers."

Flip charts

> "...a simple tool which I suspect you will find in 95 per cent of the schools in the United States."

Reading accelerator

> "...we have found devices such as this do improve children's reading rates."

Reading rater

> "...after the child has worked in a group, we try him at this machine for individualized help."

Phonograph recordings

> "We've had a tremendous growth in the use of recordings...our children are offered Hamlet done by Olivier, Samuel Eliot Morison's insights on history, Maurice Evans and Sir John Gielgud in other classic and modern plays. Shakespeare wrote to be played on a stage; he didn't write to be read in a book, and we come closer to Shakespeare when we can approach him in this fashion..."

Tape recorder

> "We find that our kids and our teachers develop tremendous excitement and drama in putting their plays on tape..."

Language laboratory

> "We have a number of installations in our high school, wherein the student can work not only with his classmates but also independently in order to have laboratory experience in imitative reaction..."

Opaque projector

"...and, of course the opaque projector has been around a long time...but we find our pupils in English use this a great deal, particularly at the secondary school level."

Motion picture projector

"It is my strong personal feeling that the right film at the right time can contribute supremely well to an effective learning experience. The motion, the sound, the color that it brings; the emotional response it can evoke...are hard to match."

Radio

"...To speak honestly about radio: With television now on the scene, we find that we are not using it as much as formerly."

Maps and globes

"This takes us all back to the days when we ourselves were in school. But the map and the globe are tools our teachers use dramatically and well, and...some of our schools are becoming equipped with maps in three dimensions, the physical contour maps...and the globes are better."

Models (such as anatomical)

"I could give you an anecdote about the way in which we obtained this three-dimensional model. We have our budget problems as everyone does, and this particular teacher -- a very creative gal -- has a way of getting things she needs in her classes. We couldn't afford a torso model in one year's budget, so she ordered a few of the pieces. Next year she requisitioned some more. And by the following year we had the whole torso. And this is the way teachers work. They are very imaginative. Oh yes, we call the torso Gus."

Realia

"Even though we educators often have many types of realia among our community assets, we don't use these materials nearly as much as we might. Nothing is better than the real...and the real in our classroom can be anything from a parakeet to a pregnant guinea pig..."

3¼" x 4" slides

"...I would be less than honest if I said that we are doing very much with these."

2" x 2" slides

"Rather, we are working with 2 by 2 slides, and in our particular schools we are involved right at the moment in shooting four slide productions..."

Filmstrip previewer

"Individual student use of filmstrips is encouraged by making the strips and these viewers readily available for a pupil to use himself during study hall time, or to take home, just as he would any reference material."

Filmstrip projector

"Our classroom teachers are becoming sophisticated in their use of the filmstrip. For example, unless all the frames of a filmstrip apply to the lesson, teachers don't hesitate to use only those frames which do."

Sound filmstrip

"Increasingly filmstrips are being offered to us with an accompanying disc narration. One representative offering that the teachers liked dealt with the development of the American short story."

Overhead projector

"This has been called the blackboard with a memory, and it is. The teacher's message doesn't have to be erased to be removed temporarily. Now that we are well set up in our AV materials production center to make transparencies of a more elaborate type for our staff, the overhead projector is currently the most exciting instrument in the Penfield school system. Once you introduce it into a classroom...get a teacher to use it, she won't let go of it. She considers it hers to use almost constantly..and she is right."

Wireless microphone

> "Last fall I had the experience of spending a week in the metropolitan Chicago area observing schools where they are experimenting with team teaching and large group instruction. Here one shouldn't be limited to the kind of microphone that is attached to a lectern at the front of the room. The wireless mike gives the lecturer the freedom he needs to move about the lecture hall unfettered by a cable."

Teaching machines

> "...and all of us in our professional reading have been studying and trying to get up to date on the teaching machine... We are experimenting with a prototype."

Educational television

> "So far in our geographical area we don't yet have an educational television station. To date, closed circuit television hasn't appealed to us as being economically justified, inasmuch as we make such extensive use of educational motion pictures. For big news events we have used TV receivers in some classrooms tuned to commercial stations."

Microfilm reader-printer

> "We in schools are likewise faced with the tremendous problem of the storage and retrieval of information. This is going to become increasingly acute. Devices like this that can condense more of the world's knowledge in compact microfilm form for our school libraries, and yet have it available in a matter of seconds for the student who needs it...these are important. Perhaps we won't get this item through our budget this year, but you can depend on it that we'll have it pretty soon. I don't know whether we can operate like the gal with the torso model, but we'll have to get a microfilm reader-printer requisitioned some way...it just means too much to our library resources not to take advantage of this significant new equipment some way."

Motion picture production

> "...and now I wish to show you a film which one of our students made with the use of movie equipment borrowed from the school and a little faculty guidance to document his science research project, in which he used zinc sulfur as a rocket propellant. Ultimately this won for him one of the two Westinghouse talent search nominations in New York State. It shows what a fine

learning experience the making of a motion picture can be for a youngster."

Still Untapped Audiovisual Potentials

We can see from the Penfield example that it is possible for a school district to develop a vital audiovisual program, utilizing most of the materials and devices of instructional technology.

Nonetheless, even here -- despite its excellence -- the program does not take full advantage of the potential contributions which instructional media can make. The materials and equipment tend to be on the periphery of the instructional process. They are perceived as being basic, but not as basic as, for example, the textbook. Likewise, they have not been organized into a completely integrated system of instruction.

Actually, Penfield does far more original production of instructional materials than do many school districts of much greater size. The problem at the local level is that a systems approach to the teaching-learning process depends upon certain key factors that happen to be beyond local control; namely, closer correlation at the national level between manufacturers of audiovisual apparatus, producers of instructional materials (other than books), and -- of prime importance -- the publishers of textbooks.

What the layman seldom realizes is that textbook publishers perform a strategic role in the over-all advancement of American education. Today they are alert to the implications and promise of the coming era of instructional technology.

Chapter 5.

THE RESISTANCES TO INSTRUCTIONAL TECHNOLOGY

The development of instructional technology is encountering some strong resistance by educators. This resistance needs to be understood. Several causes have been so persistently apparent that they deserve careful attention.

Cultural Lag

It is difficult to get people to change their ways. Acceptance of change of any kind comes gradually, particularly if such change appears to threaten the existing order. This is the case with the new instructional media. Fitting these new instructional media into education has been a slow process, because the educational establishment has been reluctant to accept new techniques and methods where these conflict with traditional practices.

Economic Factors

Audiovisual equipment and materials are often too expensive. The economies of mass production, which household appliances, for example, have derived from a mass market, have not yet been duplicated in the manufacture and sale of audiovisual apparatus. In addition, this equipment and material must compete with other instructional materials and services for the school dollar.

Unfamiliarity with Audiovisual Instruction

Most of today's teachers have had little exposure to college instruction that makes best use of audiovisual techniques and so are inadequately prepared to use them. The new teachers who have had training in their use often find it difficult to put into practice the things they have learned, either because the professional climate in the school is unsympathetic to such use or because audiovisual materials and equipment are not available to them.

Inadequate Equipment

Despite technological innovations in recent years, much audiovisual equipment now on the market is fairly primitive and has undergone very little change since its original design. Similarly, the content of much of the instructional material available in audiovisual libraries is either obsolete or fails to meet classroom teaching needs.

Audiovisual Cultism

Ready acceptance by educators of the benefits of audiovisual instruction has sometimes been hampered by the overenthusiasm and evangelical fervor of the audiovisual specialists themselves. Frequently, the audiovisual apparatus has been overemphasized to the neglect of its usefulness in meeting educational objectives. As a result, some school administrators tend to dismiss "audiovisual" as a fad, rather than regard it as a fundamental tool to be used by teachers.

Atomistic Development of Equipment

Equipment created for other markets has often been adapted for school use instead of being redesigned specifically for use in education. Similarly, individual pieces of apparatus have frequently been developed independently, often without reference either to the teaching task, to the other types of available equipment, or to their appropriateness to perform particular instructional jobs.

Inadequate School Building Design

It is apparent that the architects of school buildings, and the superintendents who guide them, are designing new school plants that are inadequate for the use of the instructional equipment of today, much less the future.

The Threat of Dehumanization by Machine

Some resistance has been aroused by educator reaction to an imagined threat that many of the teacher's responsibilities will be taken over by machines. These teachers decry what they label as a dehumanization of the teaching process. A high value has been placed on small class size and a close teacher-student relationship. Any effort to automate part of the teaching process, regardless of its possible contributions to student learning or its benefits to the teacher himself, is viewed with alarm by these educators.

Emphasis on Information Only

Promoters of audiovisual equipment have often described it in terms which make it sound as if it is a kind of information-vending machine. This has tended to arouse resistance. Audiovisual equipment is not merely a means of transmitting factual information; it can assist in achieving many other educational objectives, such as increasing student motivation, stimulating class discussion, forming student attitudes, to name but a few.

The Literary Tradition

Our educational system has its foundations in a literary tradition.

The word, particularly if it is printed, has been the dominant and accepted way to communicate learning since the Gutenberg era. The visual image, regardless of its potency or its universal appeal and language, is viewed with suspicion when weighed against the status of the printed word.

So the innovators of instructional technology are fighting an uphill battle. There is educational resistance; this must be recognized. There are problems of teacher preparation, of equipment and materials design, of physical facilities, and of human relations that are causing lags in the application of the new instructional technology. These present very real problems to the designers of our future instructional tools.

Chapter 6.

EDUCATIONAL AND PSYCHOLOGICAL CONSIDERATIONS

The preservation of educational values and the wise application of the psychological principles of learning must underlie all considerations in the development of an instructional technology. The focus needs to be on the learner and on the process of learning.

The Teacher-Learner Needs

The teacher in the classroom tries to do three different kinds of things in reaching students: (1) work with the entire group to develop a common background of experience, (2) work with smaller groups of students who have common learning needs, and (3) provide a suitable environment and appropriate materials for learning.

These three instructional needs can be met only if the classroom is turned into a "learning laboratory," with everything in it that is needed for the job. Materials and equipment should be within immediate reach of the teacher and of the individual student. The use of these instructional materials, moreover, must provide for social interaction, differences in levels of learner motivation, personal growth factors, and other educational considerations.

The Process of Creativity

Mechanical aids can facilitate creativity if they free both teacher and student from activities which are time-consuming without being stimulating. This is especially true where the learning of routines can be programmed on teaching machines.

Inculcating students with new perspectives--particularly in those subject areas where visual concepts are important--is another benefit to which instructional technology can contribute.

The presence in the classroom of a variety of media--with a wide choice of programs designed for use by the individual student--is likewise conducive to developing pupil creativity. As teachers become more skillful in the use of these new media in the teaching-learning process, they should be able to balance the activity of the student in such a way that those materials best designed to stimulate imagination and the creative impulse can be made a regular part of the school program.

For example, the presentation of problems with different kinds of solutions may be useful; or, again, a presentation of a variety of points of view concerning a particular problem may stimulate original thinking on the part of the student. The instructional media can be used to present such problems dramatically and realistically.

One can easily envision the advent of relatively foolproof, low-cost motion picture production methods as providing opportunities for students, in their school English and social studies compositions, for instance, to develop literacy in visual media as well as in words.

Certainly the facility which the visual media offer for depicting a total situation, from which the student vicariously experiences the culture of another country or the way in which a scientist carries on his actual research, should stimulate creativity far beyond that which we have in the past been able to produce.

The great danger, of course, in these media, as in the media of print, is that they will be used only to present information having a single point of view.

The form of presentation is, of itself, significant. Witness those new mathematics programs which are designed to let the student discover basic mathematical truths and concepts for himself rather than learning them in parrot fashion by rote. Thus, even the principles of multiplication can be discovered rather than memorized. Performance of students who have so learned mathematics is proving to be of higher quality than that which was based on memorization.

The Requirements for Learning

A preoccupation with the hardware of instructional technology is not conducive to inventive thinking. We need to consider, first of all, the requirements for a whole range of different kinds of learning. We are concerned with interactive behavior, the interaction between the learner and the materials to be learned. This is what education is mainly about. C. R. Carpenter presented ten characteristics or requirements for this interactive behavior:

1. There must be the capability of selecting appropriate materials or contents.
2. There must be ordering and sequencing of the learner's interactive behavior toward certain goals or objectives.
3. There should be some control of this behavior to keep "noise" out of the system -- that is, some regulation of the interactive behavior.
4. There should be an optimum degree of intensity of this behavior -- that is, the ideal amount of attention or concentration.
5. This behavior must persist -- must be an ongoing, continuing process for periods of time.

6. There must be an optimum appropriate rate of progression (or rate of behavior or rate of interaction with the material) -- ideally, the apparatus should permit variation in this rate of presentation or of progression.
7. The behavior is cyclical and repetitive, the interaction between behavior and materials ideally moving to higher levels of generalization and abstraction.
8. There should be variation of materials -- avoidance of repetition -- variation in patterns of stimulation and patterns of required responses.
9. This interactive behavior should be progressivly extended, not always narrow and focused on particular facts.
10. There should be provision for development of generalizations.

Educational and Psychological Requirements Influence Apparatus Design

These educational and psychological considerations, then, must serve as a foundation for shaping the form of instructional apparatus. Their characteristics set the pattern and determine the form of the instructional environment and of the conditions of learning in which the apparatus will be used.

PART THREE

EXPLORATION OF TECHNOLOGICAL POSSIBILITIES

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Chapter 7.

THE CATEGORIES OF AUDIOVISUAL EQUIPMENT

The media of instruction are varied and numerous -- easily over 100 distinct types. Traditionally, these have been grouped by audiovisual educators into a number of different classes such as "projected," "audio," "three-dimensional," etc. But these classifications do not adequately describe the media in relation to their unique educational contributions. As a matter of fact, such a taxonomy of instructional media has never been completely developed despite efforts to do so.

The Conference struggled with the problem of developing such a classification. Although a limitation of time prevented the development of a definitive taxonomy, several useful models for categorizing audiovisual equipment were suggested, and a preliminary listing of optical-electronic-mechanical apparatus of instruction was assembled.

Porter's Classification of Teaching Aids and Devices

Suggested as a useful model for orientation was the classification devised by Douglas Porter.[1] He presented three general classifications of devices:

1. Stimulus Devices
    - a. Visual, such as silent motion pictures, still photographs, and projectors.
    - b. Auditory, such as recordings and radio.
    - c. Audiovisual, such as sound motion pictures and television.
    - d. Tactile, such as Braille.

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[1] Douglas Porter. "A Critical Review of a Portion of the Literature on Teaching Devices." In Teaching Machines and Programmed Learning. A.A. Lumsdaine and Robert Glaser, Editors. Washington, D.C.: Department of Audiovisual Instruction, National Education Association, 1960. PP. 116-117.

2. Response Devices
   a. Data manipulators, such as typewriters and calculators.
   b. Data gatherers, such as test-scorers and galvanic, skill-response indicators.
3. Stimulus-Response Devices
   a. Simulators, such as flight simulators and add-a-part films and tapes.
   b. Immediate reinforcers, such as teaching machines.
   c. Pacers, such as reading accelerators, reading films, and tachistoscopes.

The group felt that this classification gave, at least, a model for arranging the equipment in descriptive stimulus-response terms. It was presented only as an example of a classification, not necessarily as the best model.

Carpenter's Classification by Function

C. R. Carpenter presented an alternate classification system, based on the functions that each of the devices has to perform:

1. The manipulation, organization, and recording of information, such as in structuring knowledge and producing instructional programs.
2. The origination of this information, such as with television, radio, or motion picture "decoding" from recordings to forms for transmission.
3. The distribution of the information, such as in television, radio, tape, and film distribution.
4. The presentation of the information, such as on screens, over loudspeakers, or as pages of print.
5. The implementation of learning responses, such as by teaching machines, classroom communicators, or other "feedback" systems.

The elements of this classification system can be viewed as kinds of segments of the communication cycle: "Who-says-what-to-whom-through-what-medium-to-what-effect?"

The ASCD Taxonomy of Audiovisual Apparatus

A third classification[2] setting forth a preliminary listing of media characteristics, which resulted from an Association for Supervision and Curriculum Development seminar, presents another aspect:

1. Sensory appeals -- to eye, ear, touch, smell, taste.
2. Types of symbols -- print, speech, still pictorial-image, moving pictorial-image, sound.
3. Degrees of permanency -- ephemeral, permanent, archival.
4. Physical availability -- requirements for transmission or reproduction, portability, requirements for expertise.
5. Degree of availability to student -- in-school or out-of-school, under teacher's direction, etc.
6. Audience characteristics -- individual, small group, or large group.
7. Economic availability -- capital investment, maintenance and replacement cost, operating cost, per-pupil cost.
8. Psychological potential to stimulate or provide motivation, creativity, imagination, reinforcement, information giving, repetition and/or practice, insight and understanding, learning attitudes, independence, critical thinking, physical or manual skill, emotion.

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[2] "A Report of Proceedings of an ASCD Seminar on a Theory of Instructional Materials," St. Louis Missouri, May 19-23, 1960. Washington, D.C.: Association for Supervision and Curriculum Development, National Education Association, 1960.

Spaulding's Classification by Conditions of Use

Seth Spaulding presented still another system of categorizing technological equipment -- in relation to the physical environment in which the instruction will be conducted. These were of three general types:

1. Large-group instruction in school by means of television, sound recordings, and motion pictures.
2. Individual and small-group instruction in school by means of teaching machines, motion pictures, filmstrips, and sound recordings.
3. Home instruction by means of teaching machines, television, motion pictures, sound recordings, and reference materials.

The Significance of the Categories

The classification of audiovisual apparatus into categories has significance to the manufacturer, producer, and educator. Such analysis permits these groups to make more intelligent decisions regarding the solution to educational problems by means of instructional media.

These four different ways of classifying the audiovisual media -- by type of equipment, by function, by media characteristics, and by the physical conditions of use -- deserve very careful study. Thus, the manufacturer of equipment could well profit from an intensive study of the role his particular piece of apparatus fulfills according to the various classification systems. With such categories as guides, it is possible to develop and to use equipment with a greater understanding of its role in education.[3]

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[3] See Appendix , page , " Conference Work Form No. 3 - Apparatus Analysis," for a tentative check list of equipment characteristics, which was provided to Conference participants upon arrival as an optional worksheet.

A List of Apparatus

It was beyond the scope of this three-day conference to consider all audiovisual media. Of necessity, attention focused on only a few devices. These were characterized as being optical, electronic, or mechanical. In the main, these were items that might be called equipment, where some invention or application of technological skill was involved in their development. A selected list of such devices follows:[4]

1. Motion picture projector
2. Motion picture production (as a student-teacher activity)
3. Television
4. Filmstrip projector
5. Slide projector
6. Overhead projector
7. Opaque projector
8. Tachistoscope
9. Reading accelerator
10. Microfilm and microprint storage devices
11. Radio
12. Telephone
13. Record player
14. Tape recorder
15. Learning (language) laboratories with visual capability
16. Still photographic production (as a student-teacher activity)
17. Three-dimensional display devices
18. Multiple-screen display systems
19. Electronic computer
20. Teaching machine

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[4] For a more detailed list of audiovisual media, see Appendix , page .

21. Simulator

22. Video-tape recorder

This list is reasonably inclusive. It is indicative of the current state of the art, and it represents specific kinds of apparatus available for teaching today. Future applications of technological skills should produce devices not now known.

Chapter 8.

ACCESS TO INSTRUCTIONAL MATERIAL

In the process of getting instructional content used in teaching, three things happen: The instructional information is stored in an accessible form; it is retrieved by some means; and it is finally displayed to the user or consumer.

The optimizing of each of these steps is a major concern of the communication specialist, be he producer, manufacturer, educational administrator, or teacher. The way of doing this depends upon the characteristics of the audience, the nature of the content, the educational objectives being served, and the physical situation in which the communication information is used. Therefore, each of the three processes deserves a careful analysis.

Storage of Information

When we talk about storage of information for later use, we are primarily concerned with storage in the form of print, photographic images, magnetic recordings, or on plastic. These are the means of mass storage in permanent form. Our educational devices are designed to display these kinds of stored information. There are, in addition, other kinds of memory-type storage systems that have potential future applications to instruction. The best known systems of memory-type storage are listed below:

1. Print in its various forms.
2. Photographic memory, wherein silver particles are rearranged to give a pattern.
3. Plastic, such as phonograph recordings and thermoplastic tape.
4. Magnetic memory, wherein electron spins are rearranged into a magnetic pattern.

5. Crystal or ferroelectric storage.
6. Electrostatic storage systems used in image-display tubes, wherein a charge pattern is stored on an insulator and used to control the electronic beam.
7. Phosphor storage with subsequent display of a light-on-dark image.
8. Scotophor storage, wherein dark information is stored and displayed on a light screen; the brighter the room, the better the image. The contrast, which controls the quality of image, is independent of intensity of illumination, although it does vary with color of illumination.
9. Mechanical storage. This would include such devices as the pneumatic computer, the desk calculator, or the abacus.
10. Electric circuits of one form that have two states of opposite-phase oscillation.
11. Biological storage methods, as exemplified in man's brain itself.

This list represents a purely mechanistic approach to the storage of information, and only the first four are being used in education. The phosphor of the television tube is functioning chiefly as a display device, not primarily as a means of storing information. Other phosphors, however, can store information for years.

It should be noted that the uses to which an individual medium might be put are often a function of that medium's memory-storage characteristics. For example, the size of 8mm film is itself a limiting factor in its display potential. Such film could not be displayed in the same size, with the same brightness, with the same sharpness, and with the same impact as 70mm film.

Some Provocative Suggestions for Storage Systems

A "brainstorming" session produced some challenging and imaginative suggestions for storage-of-information applications:*

... Portable, small, high-capacity microfilm readers for individual student use.

... Repeatable TV -- TV receivers with an information-storage capability.

... Video-tape recording type devices to abstract and to store the core material or most difficult parts of a communication for later student review.

... Film made out of paper or some other material less expensive than present film base.

... Motion pictures recorded on some base other than lengthy strips of film -- disk, postcard-size plastic, etc.

... Books with sections that could be scanned by a device for display as still or motion pictures.

... Books with certain pages that have short strips of still film built in or stored in sleeves or pockets.

Retrieval and Distribution of Information

It is virtually impossible to consider the four elements of information handling--storage, retrieval, distribution, display--separately. They are interdependent. Nevertheless, each element has characteristics that warrant separate treatment.

The Conference participants gave considerable attention to some of the factors inherent in the retrieval and distribution of stored instructional information. This attention focused on the employment of some type of closed-circuit electronic system for the distribution of instructional material into the classroom or individual student carrel (study-position); material such as motion pictures and still films, printed reference material, audio recordings.

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*The purpose of these "brainstorming" sessions was to facilitate the free flow of ideas, no matter how improbable or unfeasible. Because they are included, the reader should not assume that they represent a prediction of what will happen, but rather suggest "blue-sky" ideas of what possibly could or should happen.

With the tremendous increase in man's knowledge--doubling every eight years or so in the sciences--the need for ready access to information is apparent. Teachers are often handicapped by the great difficulty of securing special instructional materials on loan. Particularly in the case of instructional films, even under the most favorable of present conditions there is a delay of days, weeks, or months in obtaining the specific materials needed to deal with a particular problem. Obviously, such a gap between need and satisfaction of need is intolerable today. The ideal, of course, would be instantaneous access or, at a minimum, a waiting period of only a few hours. Present retrieval and distribution systems of instructional material resources are totally inadequate.

A solution by means of electronic, closed-circuit access to stored printed, pictorial, and audio instructional materials was strongly supported and as violently opposed.

> Although the topic was vigorously explored, the conferees as a group could arrive at no uniform opinion as to the ultimate role of electronic display systems in the classroom. In the sections that follow, the pros and cons of this question are reported.

The Case for an Electronic Display System

As a substitute for the projector in the classroom -- manually operated by the teacher or a student -- and the physical transportation of films and other materials from a central library, there might be closed-circuit television transmission of the desired instructional information, available within a matter of seconds or minutes and recallable on demand by a telephone-dial type of instrument. Each classroom would have a TV-type monitor -- eventually, a large mural flat-wall screen -- for the display of films (or excerpts from films), filmstrips, television programs, or printed and graphic materials.

The proponents of such a system pointed out that the system would meet the requirements of an ideal teaching situation -- complete accessibility of instructional materials at the time of need: the right materials in the right place at the right time. It would fulfill the teacher's needs in connection with large-group instruction -- permitting him to illustrate the concepts being taught by merely punching a button or dialing a code number to bring up the appropriate material. It would meet the student's needs for individual instruction by permitting him to call up specific information for initial study, for drill, or for review. It would eliminate much administrative time and would reduce the amount of duplicate materials needed because of time lost in transportation and handling.

The Specifications

What might such a system look like?

In its most highly developed form, it might consist of a central library (school system or regional) wherein complete films, short single-concept excerpts from films, filmstrips, individual slides, audio recordings, maps, graphic materials, printed materials, and video recordings of TV programs are packaged in cartridge form in some kind of bank-type automatic system. Upon activation, any one of these materials could be projected over high-quality, color closed-circuit television into the classroom. A less sophisticated system might use lower quality, black-and-white closed-circuit distribution, with but manual operation at the library end. Or a limited number of materials might be available -- instead of an almost infinite number -- depending upon the current instructional content being taught, grade level of the students, and predicted use of the material.

The Case against Electronic Distribution*

The major objection raised to such a retrieval-and-distribution system was the apparent high cost. No dollars-and-cents figures could be cited, but there was general agreement that the expense would be considerably greater than with present systems of distribution. It was further argued that the image resolution of present commercial TV systems is not sufficiently fine to present the quality of image needed.

The folly of thinking that electronic distribution is a practical proposition at the present time was noted, with the warning that educators and school boards should not be misled into building school buildings that are solely or primarily planned for the use of an electronic distribution system for audiovisuals.

Costs

The problem of the cost of installation and maintenance of such a system was not resolved. Hints were given that this deterrent might at some future time be overcome by further invention and the application of mass production techniques.

Furthermore, the cost of such a system might not appear so great if it were computed on the basis of unit-of-information-transmitted or unit-of-educational-productivity (ratio of learning acquired to time spent in learning). The amount of instructional information (materials) and the consequent level of learning could increase significantly if distribution time were to be not only reduced, but also virtually eliminated. In industry, increased productivity has accompanied decreased distribution time.

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*For further comment on the limitations of televised display, see pp. ___ - ___.

Mechanical versus Electronic Systems

In opposition to an electronic distribution system, the point of view was expressed that we tend to be fascinated by the new. This fascination makes us tend to forget the old ways, which in many cases can do the job better.

A counter suggestion was advanced, opposing this perpetuation of the status quo. Through the years each of us tends to advocate a favorite medium -- be it film, television, audio, print -- and each of us tends to have preconceptions as to why combinations of or new uses of this medium with others cannot be made.

When we take into consideration facts like the doubling and quadrupling of knowledge, and the problem of producing, classifying, storing, retrieving, duplicating, and distributing information, we get to the basic question of whether we can do this any more by mechanical methods, or whether we have to seek electronic means. We are in the midst of a period of transition from a mechanical to an electronic technology.

Unlimited versus Limited-Access Systems

Must we have a retrieval system that permits unlimited access to the more than 60,000 educational films, filmstrips, tapes and recordings now available and the many times this figure soonto be available? Or could there be a limited-access (or patterned) system worked out, similar to reading lists of resources selected by the teacher for a particular subject under study? Certainly, this latter arrangement is more practical, with cartridge-loads of these materials being put into the system -- somewhat comparable to the reserve book procedure now in use in many schools -- so that students and teachers could have access to them at any time for either individual or group study.

A part of such a system is already scheduled at the University of Michigan, where hundreds of students may dial in and listen to language-laboratory tapes at any time they wish. These tapes are recorded in 5-minute segments so they can run continuously. If a student dials for a tape that is already in use, he listens to the completion of the 5-minute segment and then hears it from the beginning again. This may be used simultaneously by several hundred students, and ultimately by anyone in Ann Arbor, at a per-capita cost below that of the conventional type of language laboratory, wherein students must listen in groups to tapes at scheduled periods.

Other beginning instances of electronic distribution systems were noted. The University of California at Los Angeles is currently experimenting with a closed-circuit television distribution system, manually operated from a distribution center, over which motion picture films can be viewed in the classroom, stopped, reversed, or held for prolonged study, all at the control of the teacher.

Compton College in California operated such a distribution system for several years, with a number of channels carried into class-sized viewing rooms. There are now estimated to be several hundred closed-circuit television systems in operation in American schools. This number may increase greatly as a result of the Airborne Television experiment in the Midwest, for many schools receiving Airborne TV have put in closed-circuit systems. In a 15-county area around Columbus, Ohio, alone, there are 100 such systems now.

Finally, there are proposals for the electronic booking of films through the use of regular dial telephone lines and a computer. Although not an electronic distribution system, this method could greatly reduce administrative time in processing film-booking orders.

Some Conference Suggestions for Retrieval-and-Distribution Systems

Here are some brainstorming ideas advanced on retrieval-and-distribution systems:

- Upon activation of a punched card keyed to the lesson assignment for an individual student, data is released and duplicated. The student may then take material home for display and study in an inexpensive playback unit.
- Same idea, but with the capability of calling up this information on a portable student unit at any time and place. This is to be attaché-case size.
- Device to permit the recovery of specific information from a book, film, or other communication without requiring the length of time to view or to read the entire document.
- TV transmission to a predetermined point -- such as to a single classroom seat -- in a highly directional and circumscribed way with a clear picture.
- Student desk with capability of instantaneously retrieving an image or data that had previously been stored in the apparatus itself.

Conclusions

Despite considerable emotional heat generated by the conferees on the issue of electronic distribution systems, no group conclusions were reached on this controversial topic.

Worthwhile ideas were brought out into the open, pro and con, and it became clear that much further information is needed before educators and equipment manufacturers can apply electronic distribution systems to education. First of all, a number of accurate cost and feasibility studies need to be made -- at all levels of the school field and with systems of many different degrees of complexity.

Display of Information

In general, facilities for the display of films, filmstrips, television, or recorded material are determined by the characteristics of the equipment, at least insofar as this factor applies to conventional display of instructional communications materials. There are several other factors that the Conference considered regarding the display of such materials, however.

The Audience Requirements

We need to design equipment that can take care of a wide range of conditions for learning, in audiences of from one individual to large groups of hundreds of students.

Such display may be by conventional means now used. But it may also employ several simultaneous methods of displaying information. As an example, for certain large groups we may need as much as 50 linear feet of display surface, so that several adjacent sections may be used for projection of still and moving pictures, with the remainder devoted to a reflected-light chart or chalkboard area -- all simultaneously presented.

Or it may be a system of display such as that used by "TelePrompter," wherein the screen is divided into several areas for rear projection of films, slides, and transparencies -- simultaneously, if desired.

Then, too, it should be remembered that individual members of an audience look at displayed information in different ways and at different rates of perception. The problem becomes one of providing for a variation in the rate of presentation.

Light Control in the Classroom

Directly related to the problem of displaying instructional communications is that of controlling light in the classroom. Light control pertains not only to projected materials; it significantly affects the readout of other displayed materials as well.

Although the illuminating engineers' societies are spending much effort on the study of illumination problems, it is apparent that no solution is readily at hand. In fact, it was pointed out that their deliberations fail to take into consideration the kinds of classrooms we need for the use of the new educational communication media. A joint cooperative approach among educators, illuminating and other engineering societies, illuminating equipment manufacturers, and glass manufacturers is needed. Present methods of darkening rooms for projection need to be improved, it was felt.

The windowless classroom appears to be one solution to the problem of light control, and pilot projects are under way. There were, however, mixed reactions to its possible negative psychological effect upon learners and its artificiality as a learning environment. A semi-windowless classroom seemed to be a partial answer to the problem. Or the solution may even lie in some system of polarization of window walls to permit adjustment of light for different instructional situations -- or, simply, cheaper, better blinds.

Sources of Light

There are going to be substantial improvements in the brightness of the screen image, as a result of better optics and better light sources for all kinds of projection equipment. In about five years brightness should increase by a factor of three, which means that we may then project a picture with a brightness equal to today's standards with a size $\sqrt{3}$ times the present picture width.

The development of pulse xenon lamps will give a brightness nearly equal to carbon arc projection, but it will entail initially greater costs and additional safety precautions. It will probably be possible to get from 600 to 1000 screen lumens in 8mm projection. (Today's 8mm sound film is projected at approximately 100 lumens).

Incandescent lighting is improving also. It was noted that some of today's better 16mm projectors will give about 600 screen lumens, as contrasted to the heretofore normal 300 to 400 lumens for incandescent lighting and 3,000 for carbon arc.

"Brainstorming" on Needed Information-Display Systems

"Brainstorming" ideas advanced on the display of information:

* A magazine-loading film unit to insert into a TV set, with "readout" on the TV receiver tube.
* Polarizing devices to cut out window light from the outside upon the flick of a switch.

* Individual, isolated student cubicles equipped with necessary display devices.
* These carrels need not have physical partitions, but some kind of invisible acoustical screening that cuts off outside sound.
* A motion picture projector with the built-in characteristics of being able to stop automatically at certain programmed points and to start the student on a teaching machine sequence.
* A light-amplifying screen. Instead of more light coming from the projector, the screen itself would amplify the light when it hits the screen.
* Use of electroluminescent display for projection.
* Highly directional and sensitive microphones for picking up each individual student's speech in the classroom.
* Wireless feedback system for large classes in either the same or different locations.
* Microfilm reader for microdots of recorded information.
* Ultrasonic sound transmission for classroom use.
* Electronically erased chalkboard.
* A program analyzer that enables students unconsciously to feed back their liking or understanding of a communication, thus permitting the teacher to know instantaneously how well the instruction is getting across.
* An electronic-shielding paint to shield a classroom from an adjacent room so that the school may use a number of wireless microphones without interference.
* Print motion pictures by an inexpensive process analogous to a printing press.

*** A tape service similar to the Audio Digest for doctors, to be developed in other disciplines.**

STILL PROJECTION EQUIPMENT

As a way of coming to grips with some design aspects of audiovisual apparatus, several kinds of equipment were considered in detail. This chapter focuses attention on still projection equipment: the opaque projector, the overhead transparency projector, the 2" x 2" slide projector, and the filmstrip projector. (Note: Some machines are combinations of 2" x 2" slide and filmstrip projectors. In this chapter, most attention is given to single-purpose units. It is assumed that, in the case of a dual-purpose machine, its attributes as a 2" x 2" slide projector are discussed under 2" x 2" projectors, and those as a filmstrip projector under that category. Present combination machines are single-slide, manual mechanisms.)

Opaque Projector

The opaque projector is one of the oldest of the audiovisual tools. Although it is still used, it is not now as popular as filmstrip and 16mm sound motion picture projectors.

Advantages and Disadvantages

The opaque projector is unique in that it alone can project opaque, flat materials, pages from books, and student work quickly and at little or no cost.

However, it is heavy, awkward to use, expensive, has low light output, and requires a very dark room for satisfactory projection.

Chapter 9.

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The Design Question

Can the opaque projector be redesigned to overcome these disadvantages, to give it high illumination, small size, low cost? Or should this design effort be directed toward other ends, acknowledging that the opaque projector should really be replaced by the overhead transparency projector or the 2" x 2" slide and/or filmstrip machine?

Considerations

A strong case was made for the discontinuance of the opaque projector. The question was raised whether or not the opaque projector is valuable enough in instruction to warrant a concerted redesign effort. It was pointed out that technological advances in reproducing opaque material as transparencies will enable the overhead transparency projector to do everything the opaque will do and more. The elimination of one piece of expensive, bulky, and awkward apparatus would aid greatly in simplifying the repertoire of equipment needed in a school.

The question was asked: Would the opaque projector, even if greatly improved, really be a valuable teaching instrument, performing a unique role in teaching not met by other equipment? There was strong opinion that it is no longer an indispensable piece of equipment and that it should be phased out, much as the 3¼" x 4" slide has been de-emphasized. (This relates to the question of "strategic simplification" of equipment discussed later).

Opposed to this point of view is the fact that many teachers use the opaque projector every day and like it. It still has an important role to serve in instruction, particularly if many of its present disadvantages are eliminated. Have we been too narrow in our thinking of the role of the opaque projector? It might be redesigned for use, not only with flat pictures and the printed page, but with three-dimensional objects, as well.

To compete with the present capabilities of the opaque machine for immediate projection of flat opaque materials, the overhead transparency projector would entail the expense of an electrostatic or similar office-copying type of duplicating device, as well as the basic overhead projector itself. The engineers stated that the opaque projector could be redesigned to meet educator needs if the educators really want it.

Overhead Transparency Projector

In the past few years the overhead projector, used for the display of large transparencies, has achieved an increasing acceptance in the classroom. More recently, with the perfection of rapid transparency-duplicating processes and techniques for "lifting" color illustrations from magazines, the equipment is finding new instructional applications.

Advantages

This simply operated projector can be used in a normally lighted room, projects from the teacher's position at the front of the class -- thereby permitting him to face the pupils -- and provides a large, flat transparency stage (up to 10" x 10") uponwhich the teacher may write with a grease pencil or upon which he may superimpose overlays. New, rapid transparency-reproduction procedures overcome many previous limitations of the apparatus. The use of a long roll of clear acetate sheeting provides an economical way to "capture" and to store for later use the spontaneous notes which are too often lost when the traditional, wall chalkboard is used.

Limitations

It is heavy, bulky, and expensive. Because it is the kind of device that teachers need to use constantly in class (as contrasted with use for only special purposes), the cost of equipping a school with the overhead tends to be a drawback. The brilliant light of the machine's staging area causes glare and is eye-fatiguing to the teacher. Because of its proximity to the screen and the floor, the projected image is distorted in a "keystone" effect. The blower fan makes considerable noise.

The Design Question

Can the limitations -- particularly glare, noise, bulk, "keystoning," and cost -- be designed out?

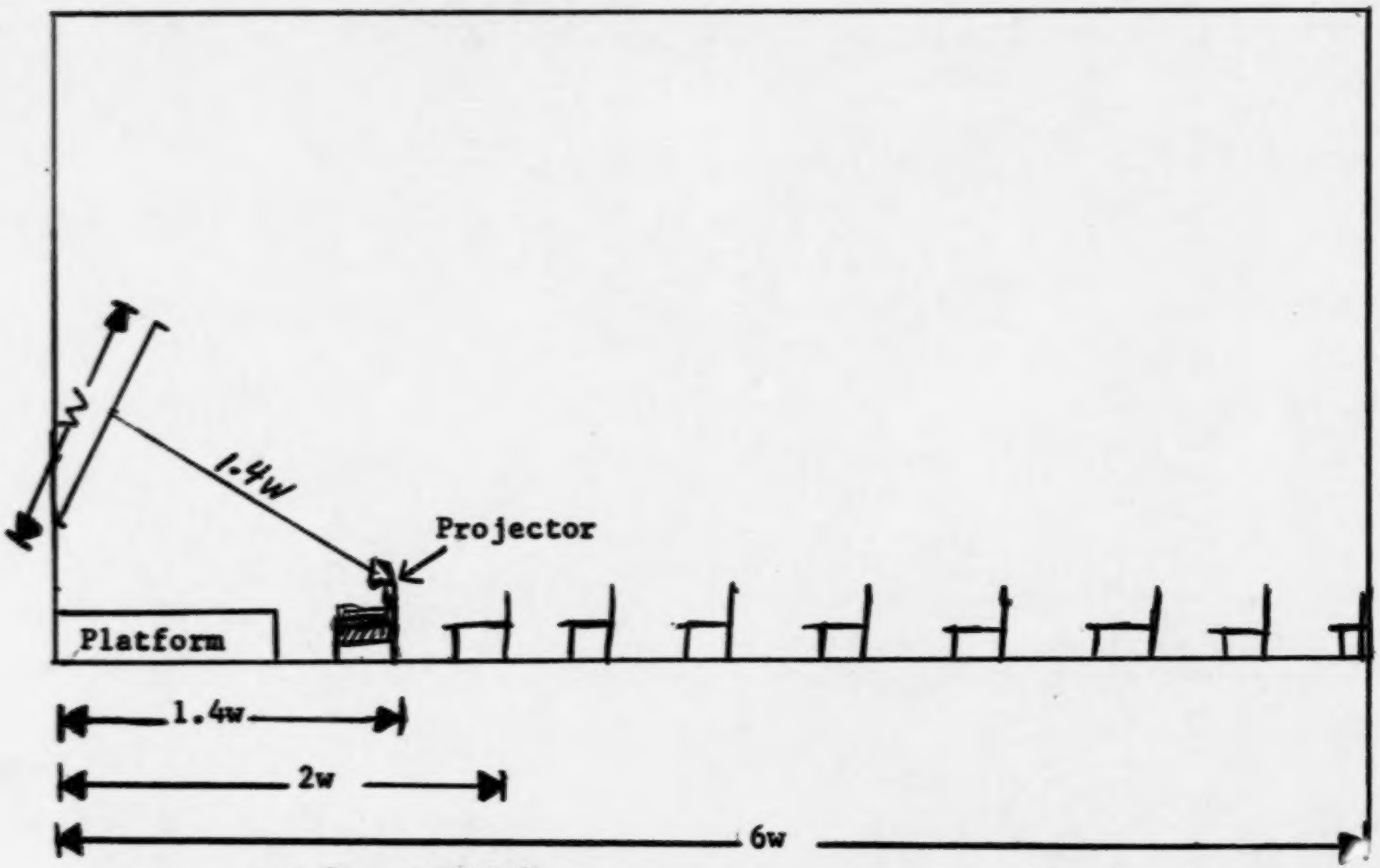
Considerations

Some practical, engineering redesign problems were suggested: Reduce the glare, offset the optical system so that the teacher can work in front of the machine without cutting off the image, reduce blower noise, have a convenient place for the grease pencils, provide for swivelling the neck out of the way for projection of other materials.

If a smaller writing surface were provided, it might still be possible to write with a pencil or pen, avoiding the problem of writing with the awkward grease pencil. This would also result in less weight and cost. However, there was strong conference support for the larger, ten-inch stage because of ease of writing and preparation of materials.

In preparing the larger transparencies for projection, however, there has been a tendency to put too much information on a slide -- particularly printed or typed material. The result has been that message information is projected in a size too small to be read by the audience. A smaller "stage" would prevent such abuse, for less information could be put on the slide; yet it would project to the same screen size. Possibly various masking arrangements to provide variable projected picture sizes from a set position would be the answer to different-size slides.

The overhead projector, although being successfully used for instruction of large groups of several hundred students, has really not been designed to fit into the teaching theaters or teaching auditoriums that are now being built.
The following illustration shows this graphically.



w = Screen Width

In a teaching auditorium of 200 seats, we would need a 10-foot screen to accommodate viewing from the rear of the 60-foot room. The overhead would need to be located 1.4 screen widths, or 14 feet, from the screen. This would put the projector almost at the first row of seats and the instructor down on the floor of the auditorium.

If it were a science demonstration center, the demonstration table would be back near the screen, and the teacher would have to walk down from this area to the projector every time he wished to use the device.

In short, there is no logical relationship between the teacher and the display or teaching methods he will use.

The question is: Do we need a new philosophy of the overhead in which such a projector would be built in as part of the teaching area? It would mean redesigning the optical ratios. But we may need this kind of rethinking of the relationship of the overhead projector to the teaching auditorium.

2" x 2" Slide Projector

The discussion of 2" x 2" slides centered primarily around the lack of standardization of loading trays and in automated presentation. The present proliferation of different methods of transporting slides has led to a situation wherein slides have to be reloaded each time a different make of projector is used. Up until now, this has not been a real problem for the classroom teacher, however, because he has usually handled slides manually and on the same model of projector.

The advent of "automatic," remote-control 2" x 2" slide projectors, having storage trays or drums of up to 80 slides in capacity, will bring about a re-evaluation of the teaching role of the modern color slide. Filmstrips -- because of their economy, compact size, and the fact that they obviate the loss of individual frames or accidental rearrangement of the proper picture sequences -- have won greater acceptance than 2" x 2" slides at the elementary through high school levels.

In the event that there is a movement toward greater automated control of slides -- particularly in large-group instruction -- there may be increased need for random-access slide projectors. If the instructor (in college lecture situations largely) has a bank of 500-1000 slides from which he could select at will, it would add greatly to his instructional effectiveness. Certain equipment is now becoming available to do this, but it is still expensive.

Inherent in the nature of both the overhead and 2" x 2" slide projector is the problem of making transparencies of slides locally without getting into cumbersome procedures. Overhead transparencies, being as a rule fairly large, lend themselves to direct hand-manipulation as 2" x 2" slides do not. On the other hand, in quantity (especially where multiple copies are needed) overhead transparencies tend to become costly. This is especially true in cases where we project onto the screen color photographs -- having a continuous-tone quality, as distinguished from line drawings.

Manufacturers of apparatus and color film might fruitfully set themselves the task of solving for the educator the twin problems of easy conversion of photographs and drawn art work to color slides, and the rapid processing on school premises of color film in either slide or filmstrip form by means of some sort of convenient "dry photographic" process.

Filmstrip Projector

Lack of time precluded discussion of filmstrip equipment. It was pointed out, however, that probably the most widely used type of projected instructional material in schools is the filmstrip.

Filmstrips are inexpensive, convenient to store, and easy to use.

This means that individual schools are building their own collections of filmstrips, resulting in increased usage.

An interesting and significant sidelight on filmstrips is that, during the past several years, there has been a great increase in their use by small groups and individual pupils. It is not uncommon to find in some schools that students consult filmstrips on a topic assignment just as they do reference books in the school library.

It was, in a sense, a tribute to the general acceptance of the filmstrip projector as an essential piece of audiovisual apparatus that more time was not devoted to it at this particular conference. To be sure, there are design improvements which can and should be made in filmstrip projectors. On the other hand, present models are highly successful; they are inexpensive, portable, reasonably efficient, and easy for teacher and pupil alike to use.

Chapter 10.

TEACHING MACHINES AND PROGRAMMED LEARNING

At the time this conference was held, it was already apparent to those present that "teaching machines" and "programmed learning" are going to have an important place in the spectrum of instructional techniques.

Because programmed learning was the subject of separate investigation by other U.S.O.E. contract groups and because apparatus specifications for teaching machines were still in a fluid state, the participants did not feel justified in giving teaching machines careful attention. The following observations, however, were voiced by participants, some of them during the informal discussions.

Relationship to Electronic Progress

It was stated by several informed participants that, at the outset, the high cost of teaching machine "hardware" will be a hindrance to the widespread equipping of individual students with facilities for programmed learning -- quite aside from the tremendous cost of preparing programs themselves. However, in time, progress in miniaturization in the electronics industry will have a distinct bearing on the lowering of costs of the more complex types of teaching machines. The ultimate flowering of these devices may indeed await the advent of an inexpensive, tiny, but highly sophisticated computer.

For the immediate future, however, the conferees felt that development of the teaching machine will have to take place in close correlation with the publishers of courses of programmed learning. At the present time, there are many things which teachers, psychologists, subject-matter specialists, programmers, publishers, and equipment manufacturers have still to discover before the teaching machine can truly come into its own.

Role of Microfilm in Programmed Learning

Conference participants reported that those who have actually turned out entire courses of study in programmed-learning form are appalled by the sheer amount of paper involved in supplying each student with his individual set of the study course. As a matter of spatial as well as financial economy, they assert that some form of inexpensive, compact microfilm -- 16mm or, better yet, 8mm -- is needed to make teaching machines practical for individual pupils in large numbers.

Need for Standardization

Currently, the whole programmed-learning methodology is in a state of flux. Manufacturers hesitate to risk going beyond the prototype stage with apparatus until the field settles upon one or a few common types of teaching machine equipment as standard.

How many "frames" of information must a machine be able to store?

What types of apparatus must be devised to do justice to the linear method? To that of the branching method? To other psychological approaches?

How important is it to be able to program graphic and pictorial nonverbal material?

Is color a needed attribute?

What about depicting sequences calling for short bursts of motion pictures?

To what extent is concomitant -- or even contrapuntal-sound important?

All these and innumerable other design questions will have to be resolved before mass production and marketing of teaching machines can take place.

Need for Compatibility

Obviously, teaching machines must be designed to be compatible with other pieces of apparatus in an over-all attempt to create a teaching-learning systems approach, as described in Chapters 16 and 17.

Chapter 11.

8MM SOUND MOTION PICTURE PROJECTION

Clearly, one challenging technological problem faced by the Conference was that posed by the advent of 8mm sound motion pictures. The discussion of this development led to a whole complex of interrelated technological considerations, cutting through problems of educational methodology to dollars-and-cents costs. In the pages to follow, the essence of this discussion will be briefed.

The Promise of 8mm Sound

In the educational field, 8mm sound film promises to be an important innovation. It gives us a chance to re-examine the whole problem of film utilization in education, from top to bottom. That is because we can approach 8mm sound film from the point of view of individual student utilization -- something that has not been possible with 16mm. Likewise, it will free us to think about solutions to better film distribution, because of the likelihood that print costs may ultimately be lowered to a point where it will be economical to decentralize film libraries.

The dream of an individual viewing instrument at each student's desk may now be a possibility. So, too, the idea of student and local production of filmic materials may also be realized. In short, there was a sensing of the potential importance of this new apparatus, of the immediacy of the problems thereby raised and of the need to come to grips with these problems without delay.

Equipment Design Needs

We must not regard the 8mm sound film simply as a miniaturization of 16mm. It requires the design and development of totally new equipment. Its promise for individual instruction, local production, and record making places novel demands upon the camera, the processing of the film, and upon the projector.

There is certainly need for an 8mm sound-on-film camera with a big magazine capacity -- 600-foot film capacity chamber providing 33 minutes of running time. This is wanted for research purposes, for performance observations of teachers and children, and for industrial record making.

There needs also to be developed some method of rapid on-the-spot film processing that would permit immediate viewing.

We must also facilitate the maintenance of projection equipment. In the event of repairs, the conventional 16mm projector too often has to be shipped hundreds of miles, and thus is lost to use for days or weeks. If, in the case of 8mm sound projectors, there were components that could merely be unplugged and a spare installed, this problem might be minimized.

Another related problem is the uniqueness of each separate make of projector. Unlike most consumer goods -- such as washing machines, TV sets, refrigerators, etc. -- which use a large number of off-the-shelf components, the motion picture projector is a hand-tooled device. Except for a few items, such as lenses, tubes, and transistors, which can be bought off the shelf, almost the complete projector is of original design. This is a major cause of a projector's high comparative cost.

The Alternatives to Conventional Threading

One of the most challenging problems to be solved with 8mm sound film is the system of film threading employed. There are two major alternatives to the conventional type of film threading we now use, wherein a reel of film is mounted and the film then threaded through sprocket drives, down through the film gate and over the sound drum to the take-up reel.

The complexity of this film-threading process has been one of the major deterrents to more extensive classroom use, particularly by non-mechanically-minded women teachers.

The two alternatives are slot loading and cartridge loading.

Slot Loading

By this method, the end of a film -- mounted on a conventional reel -- is pushed into a slot. When a button is pressed, the film threads itself.

Another type of slot-loading projector might have a slot similar to that in a portable home-style tape recorder. The end of the film would be taken off the reel, drawn through a straight slot, and attached to the take-up reel. The projector would then be ready. Years ago, the old Eastman Sound Kodascope Special achieved this in a complex way; it can be done more simply today. The film would have to be rewound, although it would be possible to make it non-rewinding.

With the slot-loading projector, the standard picture-to-sound distance could remain unchanged. The projector would still use the conventional intermittent-film-advance movement. In large quantities, this machine could probably be produced to sell for between $200 and $250.

When modified to serve as a viewer for individual instruction, this projector would have many characteristics in common with present film-editing equipment. It would probably use a small rotating glass prism and give a picture on a ground-glass or translucent screen. The student would merely put a reel of film on a spindle, draw the end of the film through the slot, attach it to the take-up reel, and press a button. Such apparatus would have to meet much higher standards of picture steadiness and sharpness than present editing equipment in order not to subject children to severe eyestrain.

Magazine or Cartridge Loading

In the magazine-loading projector, the film is spliced into an endless loop and loaded in the magazine, where it keeps getting pulled back into the magazine as it is fed out. This magazine, or cartridge, is shoved into a recess in the projector for projection, and is then ready to be run. In most models, this type of magazine reduces the separation between the picture and the synchronized sound on the film to about one or two inches.

Several engineers at the Conference pointed out that the threading path for sound film is much more complicated than in the case of a silent projector or of a ¼" tape recorder. Likewise, creating a foolproof cartridge-loading design for the traditional-type intermittent pull-down projector is more difficult than for a nonintermittent or "continuous" type unit. This nonintermittent film movement might be called one of "optical compensation," wherein the film goes through the projector in a continuous motion, and something such as a rotating prism rectifies this motion and gives a steady picture on the screen.

A personal opinion by a qualified expert was that an individual study unit could be produced quite inexpensively, the sound coming from a tiny loud-speaker or through earphones. The picture would be similar to those on editing viewers. Optical compensation could be achieved by a small rotating glass prism. This individual self-instruction projector might, if produced in quantity, sell for from $50 to $100. If used for group instruction, however, the more complicated optical system needed to transmit enough light for a normal-size screen image would raise the cost to at least that of present 16mm projection equipment.

This type of magazine-loading projector would permit both fast forward winding and backward rewinding as on today's tape recorders. It would thus be possible to skip material not needed or to return rapidly to other material for review.

Opinion differed as to the necessity for the kind of magazine described above. It was felt that there were other possible designs for magazines. Some of these would require a change in present optical and film-transport standards.

Number of Runs With Repetitive-Loop Loaded Films

How many successive runs can be obtained from 8mm film with a magnetic sound track, loaded into a repetitive-loop, self-rewinding magazine? Experience has shown that 2500 repetitions are not at all unusual. With magnetic stripes on both outer edges of the film as supports to keep the emulsion from rubbing, 5000 repetitions are possible. 8mm film lends itself much more efficiently to this type of repetitive-loop operation than does the wider 16mm film.

The Optics of Nonintermittent Action

An expert opinion was expressed that "continuous" -- or nonintermittent -- action projectors result in a significant loss of light. Such a light loss, coupled with the small 8mm size, might because of reduced quality have a detrimental effect on the acceptance of 8mm film.

Instructional Considerations

It appeared that some form of easy-threading equipment could be engineered to meet instructional requirements. If educators really want magazine-loading equipment, it can be made. However, if school people would be content with slot-loading projectors, the design problem would be greatly simplified. The Conference arrived at no clear-cut statement of educators' needs or preferences.

Economics of 8mm Sound Film

It was maintained that the economies envisioned for 8mm sound film would ultimately make 8mm a major educational medium. There was lack of agreement as to what, however, might be the eventual selling price of an 8mm sound print.

Today, with 16mm prints, an educational producer can expect to sell 700 to 800 prints of a successful production. If 8mm sound release prints could be priced at a significant reduction from the 16mm price, it has been hypothesized that school systems would tend to equip individual school buildings with their own film collections, as is being done more and more with book libraries.

If 8mm prints are to achieve mass-production "runs" similar to those of the paperback book publishing field, the price of 8mm sound prints will probably have to be set lower than $25 for a 10-minute color subject, as compared to $100 - $120 today in 16mm.

Light Sources for 8mm Film

In the past five years, we have seen a doubling in screen brightness of 8mm film of from about 60 to 120 to 130 screen lumens. That, too, within the next three to five years, we could double. In general, 16mm film is now about equal in quality to 35mm film of about a decade ago, and 8mm film is now equal in quality to the 16mm film of two decades ago.

In Europe, 8mm arc projection on a 17-foot screen in a London theater has been reported. The trade press carried a story that a similar type of projection was given at one of the recent Cannes film festivals to 8mm film. Increasing use of xenon lamps (see Chapter 8), to achieve a screen brightness close to carbon arc projection, means that 8mm film might eventually find use in auditoriums.

Quality of 8mm Prints

Apprehension was expressed about the possibility of a degradation of 8mm release-print quality as a result of some commercial laboratory processing practices. Printing, by optical reduction, of four rows of 8mm color-negative images on 35mm film and then contact-printing these to the final release print may reduce quality to an unacceptable level. A less acute but similar problem has long plagued 16mm film, and even today its quality is commercially far short of that which could be obtained at only a moderate increase in cost and with better engineering. To obtain optimum quality in 8mm sound prints may require the use of 16mm intermediates for optical reduction and careful laboratory control.

PART FOUR

CONSIDERATION OF SOME FUNDAMENTAL ISSUES

Chapter 12.

TELEVISION AND VIDEO-TAPE RECORDING

It was forcefully pointed out that, at least in colleges and universities, the press of rising enrollments, combined with a dearth of faculty, will make the use of television and other means of automated instruction imperative. The present tendency is to use both open- and closed-circuit television to help solve the problem.

Although this report points up some of the technical limitations of television, it should not be construed as a criticism of the medium itself, but rather as an indication of the interest of the engineers present in such technical considerations. The use of TV as a distribution and display system is discussed in detail in Chapters 8 and 16 rather than here.

Two Case Studies of ETV

Two university television case histories were presented as examples of the extent of use of closed-circuit television, its costs, and TV's importance in helping to solve instructional problems.

As an example of the impact of TV on university instruction, it was pointed out that in 1958 the Ohio State University UHF station was used to teach 574 credit students, and three years later at the time of the Conference was teaching over 59,000. In addition, a closed-circuit system was being designed at the request of academic departments to transmit freshman mathematics instruction to a total of 6,000 students and freshman zoology instruction to a total of 10,000 students annually. This system would cost $150,000 for video-tape recorders and $25,000 for the closed-circuit system to 14 campus points.

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Pennsylvania State University was reported to be in its sixth year of closed-circuit TV operation with a projected fall 1961 ETV enrollment of 10,000 students in 21 courses. Three separate closed-circuit systems are operating on the campus, valued at $50,000 each and costing about $40 an hour to operate. The estimated saving to the University in classroom space and faculty time is around $100,000 per year. In addition, a larger-screen projection Eidophor system was being installed in a 1200-seat auditorium.

Research Establishes Effectiveness of ETV

Hundreds of research studies point conclusively to the instructional effectiveness of televised teaching, both over open- and closed-circuit systems, and at all levels of teaching. The more exposure that students and teachers have to television, the more favorable they are to its use in instruction.

Feelings about Television Expressed

However, a tone of negative reaction appeared to color some of the discussion on ETV. Several of the educators present criticized the quality of current instructional TV programming. They expressed concern over the possible detrimental effects of widespread broadcasting of certain instructional TV programs. In particular, the Midwest Program on Airborne Television Instruction -- in which video-tape recordings are being broadcast over several states from a high-flying airplane -- was singled out for adverse criticism, largely because local control over the curriculum was being removed. In addition, they felt that large numbers of children, with varying degrees of ability, were being forced, despite these differences, to proceed at an arbitrarily uniform class rate.

At times, the emotional involvement of the Conference participants with these issues tended to detract from the objective assessment of the technical capabilities and instructional applications of the television apparatus itself. The spirited discussion was symptomatic, however, of the intensity of feeling that is being aroused by these technological innovations.

Reliability of ETV Systems

The reliability of ETV systems is adequate for regularly scheduled, larger-scale use, as proven by operations in several universities. It was requested that reliability be further increased to reduce costs of operation and maintenance.

Technical Improvements Needed

The cameras need to be improved. More sensitive camera tubes * are needed to reduce the light level in the studios and classrooms.

We need to provide more economical switching and distribution systems including distribution to dormitory rooms, lounges, and other places that must utilize television in order to accommodate instructional needs.

Our receivers are not satisfactory. As a rule, they have not originally been designed for classrooms, but for living rooms. In classroom situations, it has been found that the three- or four-inch speakers coming out the side through a grille are inadequate. Hence, it is necessary to add auxiliary speakers for classroom use.

Whenever closed-circuit systems are installed, talk-back systems -- from classroom to televised teacher -- should probably be provided as well. Some instructors will ignore this feature, but others will find it extremely helpful.

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*Since the Conference, new vidicons have been produced with greater sensitivity and an automatic iris control for easier operation.

We urgently need a response station on the desk of every student. Not only will these be used for individualized instruction in connection with television, but for testing and evaluating student progress, as well. To facilitate student tests, it was proposed that IBM-type cards, for instance, be marked by students at their desks, and fed through a substation to data processing machinery, so that the next morning the instructor could have for students their grades, as well as for himself a statistical analysis of them, item by item. This may be one of the most urgent needs of large universities.

Video-Tape Recording

Video-tape recording and playback of picture and sound is in regular professional operation. Smaller-scale equipment is operating in laboratory experiments. It is rumored that there are developments which may make it possible to produce a black-and-white VTR to sell somewhere near $500 if manufactured in quantity. Some technological breakthroughs are needed, but they will come. The Conference felt, however, that it was still too soon to hazard a guess as to a timetable for progress in this area.

Chapter 13.

QUALITY AND STANDARDS

This is a most critical and appropriate time in the development of instructional apparatus to establish basic standards of performance for newly developed devices.

When standards are set up, they are always interchangeability standards. They are never quality standards.

There is no ready solution to this problem, but some efforts are being made to find one.

The Department of Audiovisual Instruction of the National Education Association (DAVI) has formed a Technical Standards Commission for the study and development of standards and guidelines for production and/or selection of physical facilities, buildings, and equipment related to technological instruction. This group is attempting to find a generally acceptable method of procedure for suggesting performance standards.

Their thinking, so far, relates to the establishment of certification procedures, so that manufacturers and the schools can be freed from having to go through competitive performance demonstrations within every school purchasing unit. For instance, a reputable independent testing laboratory might be sought to assist in writing the standards and conducting performance-for-certification tests. Here, however, legal aspects of the practice would have to be taken into consideration.

It was felt that responsible members of industry would probably react favorably if the specifications were written in terms of performance, and not in terms of competitive and restrictive features of the equipment.

A comparison was made with the Federal Aviation Authority, which conducts a test center for aviation equipment. It was pointed out, however, that the FAA is a government regulatory body which has the duty and authority to write, publish, and enforce performance specifications. There is no comparable body in education. In fact, at the present time educators have not even furnished manufacturers with information as to which performance characteristics are significant. And without this information there is no possible way to rate a product. It is first necessary to know for what to test.

All in all, it appears that there are enough technical and professional societies in existence today to work on solutions to most of the problems. The SMPTE, perhaps in cooperation with DAVI, could do much to help find a solution to this complicated but pressing matter.

Channels for Establishment of Standards

What should be the role of the Federal government -- and particularly the U.S. Office of Education -- in setting standards for instructional equipment? In the past, the U. S. Office of Education has never attempted to set standards, as, for example, the Department of Commerce has set standards in other fields of activity where the law so directs. But should it?

The accepted channel for standardization in the U.S.A. is the American Standards Association, which operates on a purely voluntary basis. It sets standards, and people adhere to them because they find it economically feasible to do so, not because they are compelled to.

It would be beneficial for education if some reputable organization --

be it the U. S. Office of Education, SMPTE, DAVI, or an industry-wide cooperative group -- would take the initiative in saying that standards are needed for AV equipment. This body would call together groups of people who have the technical competence to discuss and improve upon such standards. Out of this discussion would come definite proposals. Once this stage is reached, the American Standards Association has adequate procedures for carrying on and for getting the standards in such shape that there would be virtual unanimity about their acceptability, if the state of the art were such that it would be possible.

These steps could be carried through effectively if originally some group in a position of prestige in the audiovisual field would initiate the process.

We can conclude that the U. S. Office of Education, in cooperation with one or more of the interested professional societies, could well assume this initiatory role.

One step immediately available to educators is to participate personally in the preparation of American standards. Under the rules of the American Standards Association, every Sectional Committee must have representatives of consumer groups on its roster. DAVI or a similar organization could request and gain representation on each one of the Sectional Committees in which standards of interest to educators are being considered.

What Do Educators Want?

Educators themselves so far cannot agree as to what they want in the way of equipment and standards. There are certain things that some educators desire, but these are often the very items about which other educators will disagree. It may be impossible to develop specifications that will satisfy all educators or even a majority of them.

It would appear, however, that educators do wish to be supplied by the manufacturer with an accurate description of the characteristics, performance, and capabilities of his equipment. Educators usually contact the salesman of a product. Unfortunately, a salesman's point of view is sometimes at variance with that of a development-and-design engineer, and even with that of the actual performance of the device itself. So educators sometimes hear claims on behalf of equipment from salesmen that they would not hear from the engineers. Increased contacts between educators and design engineers would, therefore, appear to be beneficial. Or at least a more rigorous policing by manufacturers of the sales presentations being made by their dealers' salesmen should be maintained.

Contacts between educators and design engineers would also have the useful effect of making the engineers aware of the mental attitudes and technical limitations of those who use their products. Many of the designs now being manufactured show no such awareness. A mechanism that seems fearsomely complicated to a teacher will seem simple to an engineer. Engineers will not design really simple equipment until they realize fully how badly it is needed.

The Problem of Getting High Technical Performance

In the design and marketing of audiovisual apparatus the problem of establishing quality standards is always present. It is being encountered in sound motion pictures, in instructional television, and more recently in language laboratories. Several sides of the quality problem were considered.

Determining Functional Specifications

A first step in preparing for the design of a piece of instructional apparatus would be to write out, in considerable detail, its functional specifications, justifying the need for each one of them -- "What do you want this equipment to do, and why do you want it to do it that way?"

For example, take the functional specifications for a highly directional classroom microphone. This is easily attainable, provided that we are willing to settle for a quality of sound equivalent to that of a pocket-size transistorized radio. The functional requirements might indicate that this level of quality would be adequate for our purposes. However, if we needed very high-fidelity pickup, the design problem would be much more difficult.

This might be called a "strategy of design," and this strategy precedes even the writing of the functional specifications. We need first to get the educator to think of his problems in terms of seeking to eliminate or minimize them by technological solutions. How do we get this strategy initiated? And then how do we get the problem and the person who appreciates the problem together with the people who could potentially solve the problem technically?

As a way of attacking the technical-design problem, the various professional educational organizations might make a practice, when setting up commissions or committees, of including members from outside the educational profession, but drawn from within the groups, firms, and individuals who eventually are going to have to produce the equipment and the materials to go into them.

This has not generally been done in the past.* Thus, we now have a situation wherein those people engaged in producing materials and equipment are not in close contact intellectually with the people who are trying to get their problems solved, and who speak for the ultimate consumers.

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*However, from June 26, 1944 to August 31, 1956, a Joint Committee of the U. S. Office of Education and the Radio Electronics Television Manufacturers Association on School Equipment Standards studied the problem of school equipment design.

Technical Quality: Film Vs. Television

All U. S. broadcast entertainment and commercial television facilities are built around a 525-line standard corresponding to 4.5 megacyles bandwith, and it would be as hard to change that standard as it would be to change the gauge of all the railroads in the country. What does this signify to education?

It means that the resolution of the image is fixed in the same sense that the grain structure of film fixes its resolution. When compared to 16mm film, the resolution of images in household television sets is inferior, and is about equal to 8mm film today. The tonal, or gray scale of the photographic image is about the same as that of the television image when viewed under the same conditions of lighting. It is possible to put a tremendous amount of information on a very tiny piece of film and to be able to read it. As a matter of fact, there are photographic emulsions available today which approach the resolution capability of lenses themselves.

Closed-circuit television potentially does not suffer from this limitation to the same degree that broadcast television does, however. There are 1200-line television systems available, and some 2000-line systems have been made for special purposes. One problem, of course, is the higher cost of this equipment and the inability to spread the equipment costs over the big communication and entertainment markets because of their commitment to the 525-line standard.

About 15 years ago, a committee of the SMPTE measured the amount of information on a 35mm theater screen. It was found to be on the order of 25 megacycles or above, depending on the specific type of film stock utilized. The typical home-television installation, in comparison, is probably between 2 and 3½ megacycles out of the available 4.5 megacycles.

How Important Is High Quality in Instructional Materials and Equipment?

There is no question about our need for high-quality education. Nor is there a question about the importance of high-quality equipment that will stand up under repeated use. The question may be asked, however, as to the level of technical excellence needed in the communication carrier itself. For example, for classroom use, do we need the fine-grain resolution of 70mm film, or is the lower resolution of the 8mm film or the commercial TV image satisfactory? How important is it to have a good quality color image? Do we need stereophonic sound, or will monaural or limited-frequency-band sound reproduction result in as much learning?

It may be that the high quality of motion picture films, as compared to the relatively poorer quality of kinescopes of televised or video-taped lessons adds little to the educational value of the images. The most important thing is the program content. It was surmised that, when the student "fills in" in his own mind the information missing from the communication carrier, he actually becomes more involved and thus consequently learns better. This may, in fact, be a function of the type of information being communicated. If students are watching a very generalized event -- such as a re-enactment of history -- technical quality may not be a factor; but when viewing a map for information, where detail and specific data are needed, technical quality may be very important. There is even a question among linguists as to the amount of fidelity needed in language laboratories to teach foreign languages.

No conclusions were reached about the level of technical quality needed in instructional communications. In general, the engineers tended to favor higher standards of technical quality. Educators expressed some reservations as to the need for such extremely high fidelity, yet favored attempts to design for optimum quality rather than for the lowest common denominator.

Chapter 14.

COOPERATIVE DEVELOPMENT OF EQUIPMENT

Should instructional equipment be developed with the assistance of government subsidy? What kind of education-industry cooperation in the development of these devices is needed? Such questions occupied the attention of the Conference participants and led to a clarification of position by the several groups represented.

Private Development vs. Government Subsidy

It would seem that, up to recent times, manufacturers of audiovisual equipment have felt that the school market was not sufficiently lucrative to warrant their investing the kind of money that would be required to develop highly specialized instruments for education. Has this situation now changed? Does the potential of the educational market now encourage substantial private industrial development? Should the manufacturers develop such equipment without the assistance of government subsidy?

Some Manufacturers Say "No Support Needed"

Some representatives of manufacturers said in effect: "We don't think we'd care for government assistance at this particular time. We should prefer to develop, manufacture, market, and distribute our own product and take our chances of being right or wrong."

It would appear that, although there is some government help in the purchase of equipment in schools today, there is little government funding for research and development of equipment by manufacturers. Apparently, some companies would prefer to build theequipment themselves without government subsidy money and thus retain the proprietary rights to the resulting product.

Proprietary Rights of the Government

In the development of any product with government funds, there arises the problem of the proprietary rights of the government. The rights that the government exercises will vary. In some cases a government agency, such as the National Aeronautics and Space Administration, will control everything that is invented with its money. There are other cases, however, where Federal agencies are attempting to get extraordinary cooperation from industry, and they are willing to let contractor business concerns have some proprietary rights to those products which their technical people develop. The U. S. Office of Education, similarly, shares patent rights with universities and other groups.

Possibly the closest parallel to the situation in the field of education is the experience industry has had with the military. One standard military procurement contract gives the government the right to make, use, or have made for its own use the patentable item on a royalty-free basis. In the military sphere, this is not too hard to live with, because the government has military uses for the product or invention which ordinarily are distinct from the commercial uses of the same patents.

In the situation with which we would be faced in the educational field, however, the government's interest could well become identical with the commercial interest, and the conflicting interests would be hard to sort out.

We need to find a viable way of providing some incentive for the manufacturer to exert his engineering capabilities and to develop specific items under contract for an educational market that is essential to the national welfare, but not necessarily self-supporting.

A Dilemma

This situation results in a dilemma. If the manufacturers do not see a profitable commercial application for a product, they are not going to be too interested in it. They are reluctant to solicit Federal aid if they must relinquish ownership of the patents resulting from their work. Research and development laboratories -- staffed with highly competent, highly paid, scientific and engineering experts -- are today the solar plexus of many a "growth" company. Might it not be too much to expect a corporation having responsibilities to its own stockholders to devote major R & D efforts to the creation of products for a specialized market, such as education, which has been of heretofore dubious profitability? As a result, the now-needed kinds of developments in education have a definite kind of chicken-and-egg relationship. Unless this bottleneck is broken, we may not get truly significant breakthroughs in equipment design.

Some Educators Say "Government Subsidy Needed"

Educators can name dozens of educational products that need to be invented -- miniaturized language laboratories, individual 8mm sound-film viewers, small computers feeding random-access projectors, for example -- but these are not commercially profitable items. There exists no ready-made educational or commercial market for them. So they don't get developed under the present system of design and production.

We need to crack this circle somewhere. If Federal aid isn't the answer and if foundation support isn't the answer, then where are we? Education is in a position where it takes the crumbs from the commercial exploitation of the photo business and the hi-fi business and the television business and tries to adapt them to school use. If and when it is commercially or militarily desirable to make a wall-television-screen projector, for instance, we shall have one. Not until then. But maybe education ought to have it right now!

To cite an analogous situation, where would air transport be if each of the major developments in plane manufacturing had not been subsidized by Federal defense funds? Every major advance has essentially been subsidized in its development under the cloak of military preparedness, and it had a direct relevance there. But shortly after it was available for military purposes, it also became useful for civilian transport. The analogy is very close, except that we haven't had this emphasis placed on the development of educational instrumentation.

In short, a number of educators felt that, unless there was some kind of Federal government financial support to overcome industry's reluctance to invade an unknown market, the necessary educational equipment would not be developed.

However, there was industry opinion expressed that an immediate large market for a product would not be needed if there was an indication that sometime in the future there would be a volume market for the particular item.

Case History of the Language Laboratory

The language laboratory can be used as an example of a rapidly growing instructional technology. The concept of the language laboratory was originated by some astute language educators, and was assisted somewhat by military development and use. But it was exploited primarily by commercial people, who saw the opportunity for its rapid development as well as the original uses to which the language laboratory was put.

It was this commercial impetus that got the language laboratory off the ground, sparked by large sums of National Defense Education Act money. The result has been the marketing of many types of equipment -- unfortunately some of it substandard -- and a burgeoning of manufacturers, from about four only six years ago to over thirty-seven today.

In the past three years, the number of language laboratory installations in schools has increased from less than 100 to over 5,000.

Need for a New Art of Introducing the Novel

Perhaps what we need is a new art or technique for introducing the novel, the innovative idea. This may depend on whether the research is done in the isolation of the laboratory or in the dynamics of a use situation. This would call for research done near the point of use, involving the people who are going to accept it, and relating the findings very closely to the emerging needs of the situation.

It was pointed out by the educators at the Conference that education, technologically speaking, is in a primitive stage. So far, educators have not been in the habit of thinking technologically. That is, if they have a problem, it never occurs to them that it might be solved by technical means. This fact presents an obstacle both to market research and to the introduction of any new product in education that does not have an identical lay use in the normal, commercial market.

It could be that both educators and the producers of educational equipment have grossly underestimated the potential usefulness of mechanical aids for education. The increase in learning efficiency obtainable through these techniques is just not appreciated at the present time. Their application may become apparent within the next five years or so. It may have a bearing on markets outside of schools, colleges, and universities --

the military, foreign aid, religion, industry, adult education.

Industry-Education Cooperation

The need to overcome a reluctance on the part of education to cooperate with industry was expressed. The separation of education and commerce is deeply ingrained in American education, and it has led to some wasteful lack of communication between these two groups.

Cooperative Activity Within Education To Define Needs

Education has neither done an effective job of identifying its needs for instructional instrumentation nor developed clearcut specifications of these needs. Educators have tried to adapt the technology devised by industry, and have then complained that it does not meet instructional needs. But no directions have been forthcoming from educators in advance of development so that industry would have some guidelines or directions.

This situation may arise, in part at least, from the literary orientation of the teaching profession. Educators just don't think in technological terms. In fact, all too often they find that technological solutions to educational problems are repugnant.

Machinery Needed for Closer Industry-Education Cooperation

This involves a long-term cooperative research and development program that will cause educational leaders to understand the economic realities of equipment manufacturing and marketing.

Similarly, it should help industrial people to recognize the expanding and unique needs of education, as distinguished from the consumer market for commercial products.

Need for Cooperative Industrial Activity To Develop Instructional Systems

Most manufacturers of audiovisual equipment make one or only a few of the many devices and materials needed for the instrumentation of entire types of educational systems. As a result, they often have expectations and make claims for their equipment that are beyond the equipment's capability. There would appear to be a need for these manufacturers to work cooperatively in developing a total system that will meet education's needs.

Industrial Consultation Service for Education

Schools need expert help in analyzing their technological needs. Industry has the engineers with the know-how to say: "Here is your problem. Here is what industry can do for you. Here are the limitations within which industry operates. Here is what we recommend from a technological point of view."

Book publishers have been giving this kind of consultative service to schools for years. Not only have they helped schools to learn how to use a specific publisher's materials, but all comparable materials as well, resulting in a general upgrading of the instructional program.

Educational Consultation Service for Industry

Conversely, the audiovisual industry could use more of the educational knowledge and experience of educators in the design of instructional equipment. Industry does use educational assistance, to be sure, but such service still falls far short of what is needed. Too often the educational consultant is an individual who is out of touch with the realities of the classroom application of the very devices he is giving advice about. There is need for consultants drawn from the classroom as well.

Agencies of Cooperation

The School Facilities Council and the Educational Media Council were identified as two agencies that are working with cooperating groups in an effort to bring diverse interest, backgrounds, and experience together to bear on the solution of educational problems.

PART FIVE

FORMULATION OF REALISTIC SOLUTIONS

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Chapter 15.

A SYSTEMS APPROACH TO EDUCATION

During the past few years we have heard much about "systems of instruction" and the "systems approach to education." What does this mean? How do we apply this to instruction? How do we develop an instructional system? Throughout the Conference this important idea was discussed, and the following generalizations were drawn.

Instructional Systems

The word "systems" is a difficult one to pin down. People mean different things by it. Some people tend to think of it as configurations of equipment or machines. As one begins to expand the view of system, interaction of machines with the people involved becomes an increasingly important part of it. The operations that connect the pieces of equipment become more and more significant as human beings are involved. The important factor here is the extent of the interaction that takes place among the combinations of different parts and human beings. It is not enough to put together a conglomeration of elements and call it a system. The whole object of bringing media or other things together is lost without the proper assignment of functions and the assurance that they do interact with each other. This is the real systems problem.

The Need for Instructional Systems

For many years some teachers have been combining different kinds of materials -- films, filmstrips, still pictures, models, etc. -- to realize their teaching goals. These are instructional systems at the simplest level. The fact that educators have been obliged to develop their own systems of instruction points up the need for a more comprehensive attack on the problem.

Not only do we need to develop packages of interrelated instructional materials, mutually supporting and contributing to a common instructional objective; we need also to analyze the entire educational process in an effort to make it operate at an optimum level.

Most of our instructional materials are produced as separate and distinct communications, have too frequently but superficial relevance to the real objectives of education or teaching needs. The atomistic development of equipment has already been noted. But most serious of all is the failure of educational planners and administrators to approach their tasks as problems that need solution, and then to call upon the expertise of problem-solvers to assist them.

Systems of Instructional Materials

We are beginning to move in the direction of systems of teaching materials. A certain phenomenon is occurring in the instructional materials field which we generally call "packaging." Commercial producers are beginning to do systematically what teachers have done informally for years -- "package" related materials for specific curricular areas.

True, this package is as yet often not much more than the bringing together of diverse materials -- filmstrips, recordings, realia -- that have little more to recommend them as a system of materials than that they pertain to the same subject matter. On the other hand, there are some notable attempts to examine this concept more deeply.

The Physical Science Study Committee's approach to teaching high school physics is an example. Here, millions of dollars have been expended on the production of materials, but only after a thorough study of the needs of physics teaching in certain types of high schools. This group has supervised the production of over 80 instructional films, dozens of paperback books, and laboratory apparatus not currently available. It has caused new laboratory manuals to be written and is even now having self-instructional programs prepared. This is all happening around a central concept, and a point of view, as to what the content of high school physics should be.

Although nobody sat down at the outset and proclaimed publicly, "We are planning a system of materials," it is that nevertheless. Possibly the key is the fact that it was planned, that there is a reason for what is being produced. All the materials are being developed out of this planned concept.

Systems of Equipment

Perhaps the recent success of the language laboratory is due to the fact that it was set up, not as an isolated device, not as a piece of equipment designed to serve many diverse purposes, but rather as a total configuration of equipment and materials to meet certain aims. This is the fundamental purpose of any system. Another example of such a system is the "TelePrompter" display installation.

This means that such apparatus as record players, recorders, motion picture projectors, and slide projectors can be combined into an integrated system utilizing the unique characteristics of each kind of device to achieve the teaching goal. In usual practice, each of these pieces of equipment is used independently of the others instead of being employed as a part of an integrated system. Now, this type of display often takes the form of a battery of projectors -- at the rear of a classroom (normally large-group) -- projectors all controlled by the teacher with push buttons at the front of the room. The projectors can be started and stopped at will. This is a step toward an instructional equipment system, but only a rudimentary one; and each installation is custom made. There is need for the development of control units into which different pieces of existing equipment can be plugged and which are under the direct control of the teacher.

Let us not forget, however, what had to be learned rather painfully in the military field -- that a system will function effectively only if its component parts are individually well engineered and efficiently manufactured.

What We Need in Order To Develop Such a System

It is becoming possible now to do things in the schools that were not feasible a few years ago. However, we are doing this under the old operating patterns. We need a new approach for the development of an instructional system.

First, we are going to have to have centralized planning.

Second, we shall need to involve people in this planning and execution who are not now working side by side -- curriculum specialists, audiovisual specialists, book publishers, audiovisual materials producers, equipment manufacturers.

Third, we need to have access to top scholars and content specialists to work with this group.

Fourth, we will need highly qualified classroom teachers.

This is an unusual kind of team. On the whole, we don't find these kinds of people working together today.

The first thing the people making up this group will have to do is to learn to understand each other's problems and methods. At the present time, for example, the "top scholar" and the "highly qualified classroom teacher" often know nothing about the characteristics of the sound motion picture as a means of communication.

Then, in order to tackle the instructional problem effectively, this group will need to describe in precise terms the specific objectives it proposes to achieve. Next, its members are going to have to break these down into much narrower segments of knowledge than those with which we normally deal. The human behavior we wish to achieve must be described in considerable detail and accuracy. Now, at the same time that we are building this system, we have to be careful that we are not building it too tightly. We need to be able to supply more resources for children to use than are available in the school, library, and home today.

Systems Analysis of Educational Problems

The juxtaposition of vitally important problems with the tools and techniques which appear to provide a solution to them has resulted in a great explosion of pedagogical activity in an effort to find the proper tool to match the problem.

Unfortunately, this area is so new that we have no integrated capability for finding solutions. No one man, no one group, simultaneously understands the educational problems, the new technological tools, and the techniques for matching them. An alliance of diverse groups is therefore necessary; and there is thus a great need for defining the proper role and responsibility of each of the groups which must contribute to the solution of these problems.

The first area of responsibility is that of the educator. He must specify the educational requirements in terms of pupil needs and instructional problems. If teaching needs are to be met effectively by an information system, they must be well defined, and some measure of their relative importance must be provided. Only the educator can assess this relative importance.

This brings us to the second area of responsibility, since modern education is becoming increasingly dependent upon some degree of mechanization. The design, construction, and sale of equipment have become a dominant consideration. This responsibility of the supplier of equipment is quite well defined, well understood, and well executed. The engineer, the manufacturer, and the equipment salesman must each perform his function in the light of the harsh realities of business competition. The proper matching of the capabilities of technology with the functional specifications for equipment is essential to the successful supplier of equipment.

And, finally, we come to the third area of responsibility -- that of providing the proper matching of equipment capability to the teaching needs. The development of adequate programs, systems of operation, and equipment configurations becomes a critical problem when large degrees of mechanization are involved. In contrast to educational systems completely dependent on individual teacher judgment, mechanization requires detailed specification of every minute step in the teaching procedure.

The proper answer is not for the manufacturer to say to the educator, "Tell us what you need, and we can built it -- if the market is there." The educator is not really in the position of being able to define his needs in terms the equipment manufacturer is able to understand. On the other hand, the equipment manufacturer does not build his product in terms of needs as the educator thinks of them.

Presumably, this is the job that the systems-man fulfills. He has fulfilled it in military programs many times; he has fulfilled it in the data-processing field. It is not just a matter of systems management, but rather of systems development as a professional discipline which is needed: somebody to understand the needs of the users (teachers and pupils) and able to describe these requirements in terms of specifications for the manufacturer.

There needs to be developed in this field the same kind of capability which has developed over the past fifteen years in the data-processing field, and over the past eight years in the handling of the large ballistic missile systems.

What we need is a professional breed of teaching-learning systems experts.

Chapter 16.

APPROACHES TO EQUIPMENT DESIGN

The Conference devoted particular attention to the design of equipment to meet the special needs of education. Although this entire report has suggested various approaches that might be made, several additional points deserve attention.

Strategic Simplification

Educators are confronted with a great variety of instructional equipment -- some of extreme complexity. Each kind has users who claim for it unique advantages. This proliferation of devices often makes the job of the teacher and school administrator more difficult.

Possibly there is a need for "strategic simplification" of the devices employed in instruction. Perhaps we need to limit ourselves to several standard devices, instead of having a multiplicity of equipment for every conceivable purpose.

Creative Approach

Some members of the Conference pointed to a tendency to invent apparatus emphasizing the didactic and the acquisition of rote knowledge. They felt that this was out of keeping with the present phase of our society, wherein we are obliged to teach students to learn by themselves, to adapt to new conditions, to develop self-reliance, to solve problems by themselves according to the scientific method. Furthermore, too little attention has been paid in school to stimulating individual student creativity. Our present agglomeration of instructional devices, materials, and techniques needs to be re-evaluated with all of these objectives in mind.

It is quite possible that whole new systems of instructional apparatus will have to be developed if we are to provide a tailor-made education on a mass-produced basis and thereby save from the danger of eradication that elusive but precious commodity, individual creativity.

Packaging

The packaging of materials and technological equipment in instructional systems was mentioned in the previous chapter. It is worth repeating in this section, however, that equipment packages designed to display several types of instructional materials may need to be emphasized.

New Frontiers in Equipment Design

The following is a check list of capabilities which any ultimate teaching-learning systems approach to education might demand of apparatus. It is excerpted from the unpublished provisional conference report of the "Study Group on Fundamental Processes in Education," held at Woods Hole, Massachusetts, September 9-18, 1959. There was insufficient time at the Princeton Conference to discuss these specifications except in passing. They were presented in the form of a background paper, and are here reproduced as a point of information.

1. The capability of reproducing visual and graphic messages (photographs, drawings, charts, printing, etc.) in high-quality color and definition.
2. The capability of reproducing the same kind of messages where an element of motion is involved (i.e., moving images such as embodied in motion pictures and television).

3. The capability of capturing such black-and-white or color images, whether static or moving, and of reproducing them almost immediately (such as with instantaneous "dry" film processing or by video-tape recording).
4. The capability of capturing such images satisfactorily via both photography and live television, in extremely dim and subdued light.
5. The capability of reproducing and displaying such images by electronic means. Here, for example, a motion picture, possibly of 8mm width, could be amplified and reproduced in color on either a large classroom-wall television screen or on an individual monitor television screen at each pupil's desk.
6. The capability of transmitting to the student visual material of many kinds, whether 2" x 2" or 3¼" x 4" slides; filmstrips; overhead transparencies (up to 8½" x 11"); opaque materials, such as flat photographs, drawings, charts, books, documents and small objects; both 16mm and 8mm motion picture films; and possibly video-tape recordings.
7. The capability of linking the classroom master screen (or screens) and those at the individual pupil's desk with outside transmission sources, such as closed-circuit or commercial telecasts, or the output of libraries of documents.
8. The capability of transmitting sounds of an independent nature, such as from tape recordings, phonograph discs, or radio broadcasts.
9. The capability of transmitting high-fidelity, stereophonic sound, synchronized -- where desirable -- with motion picture and television images.

10. The capability of transmitting, where desirable, numerous spoken messages simultaneously, from teacher to pupil or pupils, from pupils to teacher, as needed in language laboratory work, in group-conference telephone interviews and calls, or in conjunction with other activities in the rest of the school.
11. The capability of making tape recordings of the entire class, of subgroups of students, or of any single student from his own desk.
12. The capability of connecting the assortment of class and individual television-type viewing screens with a central library from which films, book pages, or documents can be reproduced upon demand and without delay.
13. The capability of making usable copies of these documents, at trifling cost and without particular fuss or bother, from the face of the individual viewing screen.
14. A central reference library having the capability of marshaling for teacher and/or student all pertinent documents and pictures related to class needs and the teaching-learning systems approach (TLSA) method of programming. Such library material could, of course, be presented according to "model concepts" by dispensing a rich variety of related information, from all points of view, on a chosen topic.
15. Introduction into the system of teaching machine components which would allow the entire class, as well as the individual student, to take advantage of whatever teaching machine techniques prove most effective for the acquisition of information, for formalized study, or for testing.

16. It would be extremely helpful if such a device could absorb composed responses by the student to teaching machine situations. Here it would be desirable to provide for analyzing results by means of nonhuman evaluation machinery.
17. A modular approach to the design of the system components, so that as much or as little of the system as would be needed in a particular instance could be bought first. Subsequent acquisition of other apparatus items in the total system could thus be achieved with maximum compatibility of components, plus over-all economy.
18. Efficient methods for office copying of single letters, documents, book pages, and so forth.
19, Requisite darkroom and production laboratory facilities to permit the teacher to make locally (or to have made for him) static or moving-image materials of classroom significance, and for the individual student to do likewise.
20. More imaginative laboratory and specimen collections; three-dimensional objects displayed by the best museum techniques and changed to fit the topic currently being taught in each class. School libraries might have display study sections where students in each course could examine the materials relevant to their immediate subjects. To be done effectively, this would, of course, require school specialists in museum techniques. Another method, appropriate for science and some other courses, is the "open lab," where students may at free times examine demonstration materials and make individual observations without formalized laboratory exercises. This technique often requires the continuous

presence of a semiprofessional teacher's aide or assistant.

21. Easy access to low-cost publications in miniaturized form; such as "Minicards," "Microcards," microprint, microfilm, etc.
22. And, finally, an all-out effort should be made by manufacturers of apparatus and materials to put this "Teaching-Learning Systems Approach" on the market at a price low enough to permit its purchase and adoption by any school system desiring to embrace this new and promising medium.

"It is recognized," the Woods Hole document elaborates, "that some of the foregoing capabilities of the system are as yet beyond the realm of possibility because of technological or economic barriers still to be overcome. This does not, however, prevent our insisting upon compromise components where such substitution makes sense as a temporary expedient. Neither should it alter our ultimate objective of assembling a teaching-learning systems approach which embraces all of the capabilities upon which the imaginative and effective education of our children and our children's children will depend."

Chapter 17.

NEW APPARATUS SUGGESTIONS

There was a general feeling among the conferees that the whole approach to the creation of new instructional apparatus has been not only haphazard, but also pedestrian. Too little imagination and effort have been devoted to applying technological solutions to various facets of the teaching-learning problem.

As an exercise to prove this point to themselves, participants devoted a couple of hours to brainstorming a list of novel, "cloud-nine" AV apparatus that might well be developed and put on the market. Here are some examples.

CLASSROOM FACILITIES

1. Polarized Windows
   It was urged that a better way be developed to solve the all too frequent school room-darkening problem. It is theoretically possible, by polarizing windows electronically, to get sufficient light control to permit projection in a classroom. Thus, building specifications might some day call for various degrees of "non-light," with a switch to "turn on the dark."
2. Room Radiowave Insulation
   Increasingly helpful in times to come would be some sort of shielding paint and/or wallpaper capable of electronically insulating a classroom against outside radio and TV interference, thereby permitting each class to make use of its own wireless microphones and transmission devices.

3. **Electronic Learning Lab**

Another development to be sought for is an electronic learning lab. This would be patterned after the more elaborate type of language lab (but not restricted to language instruction). It would feature a visual display component at each student's desk, as well as room projection capability.

4. **Study Cubicles**

Another version would be designed to provide individual student study cubicles, or carrels, linked to information-storage-and retrieval facilities, with visual display on a screen.

5. **Invisible-Wall Cubicles**

An architectural and technological modification of the foregoing would achieve the sound isolation of individual study cubicles by means of invisible "acoustical" walls, whereby the application of ultrasonic or other principles would effectively create private study nooks, open to view, but insulated against external noise.

TELEVISION

1. **Repeatable Television**

For the student, some economical, convenient method of recording favorite TV programs or sequences by means of "dry photography" or video tapes is required so that they can be played back immediately on a household type receiver.

2. **Magazine-Loading TV**

A TV set is needed into which a cartridge of film or tape can be loaded for viewing on the tube, by way of home study.

3. Wall and Desk-Top TV Screens

   Desk-top electroluminescent display devices are needed, as well as the long overdue large, flat wall-TV screens capable of needle-sharp pictures.

4. Inexpensive TV Distribution System

   Need was expressed for an inexpensive, television distribution system, presumably with desk receivers, that could be linked with various other systems.

5. Highly Directional, Pin-Point TV

   Likewise called for was a highly directional TV broadcasting system, whereby program material could be telecast on a pin-point basis to various individual students at will.

6. Portable Student TV Receiver

   Need was also indicated for an attaché-case-size portable (no wires) student TV receiver, capable of receiving from a central repository - by dialing - any book or film.

7. More Miniaturized Version of Same

   Even more convenient, it was guessed, would be spectacles to do the same*

FILMSTRIPS AND SLIDES

1. An 8mm Filmstrip Projector

   Most helpful, especially for small-group and individual viewing, would be an inexpensive high-quality 8mm filmstrip projector.

2. 8mm Slide Mounts

   One educator made a plea for the development of slide mounts for

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*As the manuscript of this report was being edited, an aircraft manufacturer announced the development of such a device.

8mm frames, so that a teacher could cut out snips of 8mm movie film and project them in a regular 2" x 2" slide projector.

3. **Magnetic-Track Filmstrips and Slides**

   It was felt that there would be a market for a projector capable of handling a filmstrip with a concomitant magnetic-stripe sound track that could be scanned while each frame is motionless for viewing. A similar device is needed to take care of individual 2" x 2" slides.

4. **Book Illustrations via Strips of Film**

   Better methods are needed for inserting, with safety, short strips of film into the pages of a book. With simple viewing devices, these strips might take care of the problem of providing profuse color illustrations, a problem that plagues the publishers of today's medical textbooks.

MOTION PICTURES

1. **Simplified Loading**

   Primary stress was placed on the need to solve the problem of providing easy-to-load motion picture projectors.

2. **Buttoning Down Loose Ends**

   A minor, but irritating, problem calls for a solution. Some better way than cellulose or masking tape should be devised to stick the outer end of a reel of film to the roll of film beneath it. It should act as if the leader were magnetized.

3. **Multiple-Track Projectors**

   If multiple sound tracks could be included on a single 8mm release print, this film could then be particularized for several age levels of students.

4. **A Hand-Held Projector**

An appeal was made for a hand-held sound motion picture projector or viewer (8mm was implied).

5. **Hybrid Book and Movie**

Another unusual request was for "books that, where appropriate, might be scanned as motion pictures, so that motion picture sequences could be interspersed with textual information."

6. **Nonintermittent Projectors and Light-Amplifying Screens**

As progress is made in electronics, nonintermittent (continuous pull-down) projectors would seem to present advantages, particularly in handling unperforated film. To overcome the normally low amount of light resulting from a continuous pull-down type of mechanism, it may be necessary to couple such a machine with a light-amplifying screen to give adequate illumination in brightly lighted rooms.

7. **Wholly New Ways To Capture Motion Picture Images**

Completely different methods of recording motion pictures might be perfected, such as on discs.

8. **Cheaper Release-Printing Methods**

By means analogous to printing-press methods, much more economical ways than now prevailing should be perfected to make motion picture release prints -- possibly on less expensive bases, using non-photographic processes.

9. **Feature Films of Postcard Size**

Still another technological innovation suggested was the ability to capture a feature-length sound and color motion picture on a sheet of film or paper no bigger than a postcard, at no more expense -- other than for copyright royalty payments -- than in manufacturing a postcard.

10. Long-run Subminiature Cine Camera

    In the same vein was a stated need for a cigarette-package-size movie camera capable of recording in sound and color, withpresent 16mm quality, up to 18 hours of program material on inexpensive film.

11. Rapid Film Processing

    Just as we now have on-the-spot methods of developing still photographs, so education needs some relatively easy, high-quality method of processing motion picture film -- color as well as black and white -- in a jiffy, to stimulate local educational (and TV) film production.

TEACHING MACHINES

1. Dual-Program Type

   In considering the design factors for teaching machines, it was indicated that there will be a call for a display-type unit capable of presenting verbal material in either branching or linear form.

2. Graphic Presentational Type

   Likewise recommended was a teaching machine, for individual student use, having the attribute of being able to display still pictures with correlated sound, as well as having feedback and study characteristics.

3. 8mm Sound-Film Type

A further refinement of the foregoing would permit interspersing motion picture sequences among single-frame portions of the program.

4. One Especially Needed Program

An appeal was made by one participant to have the audiovisual field practice what it preaches by applying, without delay, programmed instruction techniques to film and other materials production.

STUDENT FEEDBACK DEVICES

1. Wireless Feedback for Large Classes

Much in demand for lecture hall and large classroom use is a more effective wireless feedback system -- able to handle up to 1,000 students, either in the same or different locations.

2. A Highly Directional Microphone

Likewise called for were improved and highly directional microphones which individual students could use to record either their own class notes for later study or questions occurring to them in response to the lecturer's talk. Such recording would be done without disturbing the class in session. These microphones should be designed to solve today's problem of the roving microphone for audience response in big meeting rooms.

3. Direct Student-to-Teacher

One professor present put in an order for a student-to-teacher feedback mechanism -- directly wired to the human organism of the student -- to inform the teacher automatically whether his teaching is "getting through" to the student!

4. To Decipher Student Brain Waves

   Unmindful of "1984," there was a request for a "thinking cap" that would pick up an individual's thought brain wave and transmit it to a computer for interpretation.

TESTING DEVICES

1. Improved Test-Scoring Machines

   To conserve teachers' time, there is an urgent need for vastly improved test-scoring machines. These range all the way from a low-priced test scorer for multiple-choice examinations to a sophisticated device to score essay-type examinations.

2. I.Q. Testing by Pictures

   Too many present intelligence tests are based on verbal responses. Potentially, mechanized audiovisual applications can bring about methods of intelligence testing through use of function pictures.

3. Oral Examinations via Tape

   Centralized, high-speed duplication of random-access tape lectures onto 2-track tapes would permit the student to record his comments upon the instructor's lecture or to answer an exam.

4. Teacher-Student Dictating Systems

   Very helpful would be some practical form of 2-way teacher-student dictating system. This would permit a teacher to comment directly to a student about the latter's test responses, particularly on tests calling for theme writing.

5. 8mm Test-Giving Machine

One proposal called for a cartridge-loading type individual 8mm viewer in which each frame is a separate still picture. A magnetic track opposite each frame could index it. A separate sound tape could use the magnetic stripes for true-false testing. Readout could be wiped clean for re-use.

MICROFILM

1. Portable Readers

A plea was voiced for high-quality, compact (attaché-case-size) microfilm/microprint readers.

2. Subminiature Readers

Eventually, some successful readout method must be devised whereby a microfilm original, no bigger than a polka dot, can be enlarged to life size, with the image hanging in the air. The reader mechanism should be no larger than a lump of sugar, thus small enough to be carried in a man's watch pocket.

3. A Personal Information-Storage-and-Retrieval System

Near the end of World War II, Dr. Vannevar Bush described an ideal tool for the scholar and researcher which he hoped would be developed. He labeled it the "Memex." The "Memex" is still badly needed. It would be a personal, desk-sized information-storage-and-retrieval system of vast storage capacity, almost instantaneous search and readout facility, and the capability of making immediate, life-sized "hard" copies of desired microfilm frames.

RANDOM-ACCESS AND CONTENT-ADDRESS

1. **As Applied to Slides**

   Relatively inexpensive random-access 2" x 2" slide projectors are wanted. Eighty-frame capacity would be adequate for the simplest version, but 200-, 500-, 1000-, 2,000- and 5,000-slide outfits would all have varying uses.

2. **Random-Access and Content-Address**

   Conference participants generally agreed that solutions should be found to provide random-access and content-address storage-retrieval systems for the handling of books, periodicals, documents, films, pictures, etc.

3. **"Instant" Film or Video-Tape Notes**

   Likewise cited was the need for some inexpensive, practical method of abstracting or condensing, via "instant" film or video-tape recording, the salient points of a classroom lecture, a science laboratory demonstration, a field trip, etc., for subsequent review by students (and teacher). This would be a sort of filmic abstracting service, providing as audiovisual class notes significant short sequences "captured" via the moving image and accompanying sound.

CREATIVITY

1. **Better Methods**

   Better methods are needed to inculcate in youngsters drive and imagination.

2. **Manual Construction Kits**

   Good engineers, it is revealed, learned a lot when they were young by building things themselves. Today's students need to build more things with their hands, such as construction models. Construction kits should be more scientifically designed to stimulate maximum mechanical and manual dexterity.

3. Kits To Encourage Original Research

   Too often, present manual construction kits are oriented toward demonstrations of proven scientific principles. Also needed are kits designed to pose still unanswered scientific problems and to stimulate students to try to find original answers.

4. Programmed Creativity

   New types of teaching machines -- and programmed learning -- are needed to reward divergent or original thinking, thereby stimulating student creativity.

5. Creativity by Means of Computers

   Some successful method needs to be developed to stimulate creativity and intuitive thought processes in the student by the use of computers.

6. Student Movie-Making

   Student-produced movies -- even more than amateur theatricals -- can be conducive to creativity. Badly needed is a whole system of easy, foolproof cine equipment offering a way to capture lip-synchronized scenes with on-the-spot processing.

PERSONAL-SERVICE DEVICES

1. Audiovisual Abstract Service

   The torrent of articles now being published, in many languages on audiovisual subjects points up the need for a monthly abstract service available in print -- as well as in sound-tape form similar to the tape-talk abstracts offered the medical profession.

2. A Voice-actuated Typewriter

   The instructional materials field, in common with many others, could make good use of an inexpensive, reliable, voice-actuated typewriter.

3. Automatic Language Interpreter

   There is need for hearing aids that will automatically translate a foreign language into one's own simultaneously; plus a talk-back system that will provide a loudspeaker to translate one's reply back into the foreign language.

ELECTRONIC WANT-LIST

1. Modular Amplifiers

   Nearly everybody agreed that something needs to be done about the amplifiers found in today's audiovisual equipment. There was a call for higher quality, low-cost, durable, and miniaturized amplifiers -- of standardized, modular design -- that will fit interchangeably all kinds of motion picture projectors, tape recorders, public address systems, and similar devices. They should be easily plugged in or taken out.

2. Ultrasonic-Erase Chalkboards

   By means of ultrasonic or other principles, the teacher should be provided with chalkboards which can be automatically erased by merely punching a button.

3. Light-Amplifying Projection Screen

   The development of a practical light-amplifying projection screen could well bring about a revolution in the instructional materials field wherever the projected image is involved. It would be a major breakthrough, and as such deserves to be energetically sought.

4. **Futuristic Projection Lamps**

Since the nature of the projection lamp crucially influences projector design, some radical improvement in light sources is much to be desired. Still needed is a miniature, safe, cold source of intense white light.

5. **Electronic Blackboards**

On the shopping list of the AV director of the future may be an electronic "blackboard," a luminous palette capable of depicting patterns and messages in all vivid colors.

6. **Electronic Shorthand**

Elaborating upon the above-mentioned electronic blackboard, there is need to develop a far faster, more versatile method of writing than heretofore possible on paper. What is called for is a quicker way to translate thoughts into communicable symbols than by conventional pencil, pen, or typewriter. Special spectacles could be devised to harness movements of the eye muscles. Such movements, converted into electric impulses, could be used to pencil in -- at faster than shorthand rate -- varicolored symbols on an electroluminescent screen with almost the speed of thought: a "think recorder."

Chapter 18.

RECOMMENDATIONS

The USOE-SMPTE Conference on Audiovisual Apparatus made the following recommendations:

Achieving Cooperation Across A Wide Field

1. Mechanism needed for closer industry-education cooperation:

   Continuing, closer liaison between industry and education should be provided to meet the instructional apparatus needs of education.

2. More cooperation among educators themselves urged:

   Within education itself, there should be far more cooperative action to develop clear-cut, audiovisual apparatus specifications concerning common needs.

3. Closer cooperation among existing AV groups is advocated:

   The AV field tends to be disorganized. Closer intergroup cooperation among existing suppliers of audiovisual equipment, school building facilities and materials, and the leading educational associations is advocated.

4. Closer three-way liaison between AV users and suppliers needed:

   Up until now, producers of instructional materials, equipment manufacturers, and the educators have not maintained sufficient liaison among themselves in the development of integrated systems of multi-media apparatus and materials. Closer three-way collaboration would help.

5. Greater role of technical societies and trade groups cited:

   Technical and learned societies, plus trade associations, were cited as potential channels for industry to use in developing systems of instructional technology to meet educational needs.

6. Better AV feedback -- classroom to manufacturer -- essential:

   So complex is the structure of the American educational system that better feedback from classroom up through the school complex to equipment manufacturer is now imperative if audiovisual requirements are to be met properly.

7. **Viewpoint of classroom teacher deserves greater recognition:**

   The viewpoint of the classroom teacher -- who actually comes into daily contact with pupils -- should be given more recognition by industry and top-level educational planners alike when instructional technology systems are developed.

8. **Closer correlation with armed services' AV needs suggested:**

   It was found during World War II that the instructional equipment needs of the military were not as dissimilar from those of education as originally thought. Correlating future advances in developing new hardware would seem worth while.

9. **Correlation with business AV needs holds promise:**

   American business and industry are large users of audiovisual devices and materials. Closer liaison between business and education could result in faster development of more new hardware of benefit to schools.

10. **Educational apparatus needs deserve systematic reporting to manufacturers:**

    Better reporting, possibly through one central national source, is indicated, so that the large amount of information now being published on all facets of the instructional technology problem can more easily reach the individuals and companies concerned with supplying the instructional apparatus field.

11. **National "want-list" of instructional apparatus desirable:**

    Joint industry, government, and education collaboration in setting up and maintaining a national "want-list" of needed instructional equipment and materials would be desirable. Thus, time lag could be cut as science brings new advances having a bearing on AV apparatus improvement.

12. **Endorsement of USOE efforts to get industry-education liaison:**

    The Conference gave its unqualified endorsement to the activities in which the USOE has been engaged to bring about closer liaison between educators and industry representatives in order to solve the instructional apparatus and materials problems of the field.

Research and Development, Plus Field-test Programs

13. **A standard list of audiovisual apparatus needs called for:**

    While individual initiative should be protected, the Conference felt that the USOE could properly assume leadership in stimulating research and development planning projects, aimed at meeting some generally agree-upon audiovisual apparatus needs of the field.

14. U.S. government contracts for field-test demonstrations?

    The merit of contract research encompassing field-test demonstrations was pointed out. It was felt that the USOE might encourage such activity through government contracts.

15. Regional audiovisual research centers endorsed:

    It was generally felt that geographical and other factors indicate the wisdom of having some types of research into educational problems and solutions, conducted through regional research centers or institutes.

16. Scientific research into equipment effectiveness:

    The Conference was unanimous in its feeling that there should be scientific research as to the effectiveness of equipment, and as to its actual performance in instructional and learning situations.

17. Scientific research into effectiveness of media:

    Establishment of several regional research and development groups was urged to investigate and to experiment in the areas of learning instrumentation and audiovisual media.

18. Proving grounds for three levels of equipment envisioned:

    Each regional center, or proving ground, should deal with all three levels of education -- elementary, secondary, and higher. Here equipment and materials would be designed, evidence collected, and the evidence made available. Equipment would be put to use not just in simulated, but in real-life operations, aimed at collecting accurate, systematic evidence on it.

19. Regional proving centers should be pilot tested first:

    Before embarking upon a national program of establishing regional audiovisual research centers, it was recommended that the design and feasibility of such proving grounds should themselves be worked out in one or two experimental cases.

20. Educational consultation service from industry recommended:

    A consultative service from industry for education was recommended. This would help schools to diagnose AV wants and to solve instructional problems (a service similar to that offered more or less successfully by textbook publishers for years).

21. Architectural consultative service on AV matters indicated:

    Similar consultative services of the AV industry for architects are likewise indicated. The American Institute of Architects, educational facilities engineers, school boards, state educational officers need help re AV requirements and specifications.

Certain Implications of Research on Devices

22. **Better performance standards urged for AV equipment:**

A number of the Conference participants felt quite strongly that the field should have better performance standards for audiovisual equipment. The need for research into the design and effectiveness of these devices seemed axiomatic.

23. **Simpler component parts, standard modular units, appealed for:**

It was felt, on the basis of the experience of those at the symposium, that the field as a whole would like to see both simplification of component parts for audiovisual apparatus and standardization of modular units. It was hoped to effect economies, increase equipment convenience, enhance reliability.

24. **Ill-conceived standardization is, however, fraught with peril:**

Standardization in a free society is hard to come by, but that is its strength. Standardization voluntarily complied with is firmly based on the practical. Beware of too stringent standardization; time has a way of making even laudable standards obsolete and restrictive.

25. **How do we bird-band teaching needs entailing new AV devices?**

Before significant improvements can be made in present instructional equipment or new items developed, some orderly means must be found to identify those particular curriculum teaching problems which such new hardware would be conceived to solve.

26. **Varying audience sizes -- difference in apparatus design:**

Future apparatus design must take into account the wide variation in specifications which may be entailed in meeting the legitimate needs of large, normal-classroom, and small-group instruction, as well as those of the solitary student.

Typical New Devices Being Called For

27. **Devices to lighten teachers' "housekeeping" chores:**

Job analysis of an average teacher's work load reveals all too much time taken by peripheral, nonteaching duties. Such barnacle-like chores impede teaching progress. Already in existence are many business office devices that, if used, could free precious teacher time for teaching.

28. **Self-study devices for adults and the single student:**

Increasingly, attention must be focused on creating devices to serve the

individual student. Self-study by adults is a vast trend by itself. Solitary students exist at all levels, however. Today we realize that we should stop harping on teaching, should emphasize instead student learning.

29. More 8mm editions of classroom films is the plea:

Producers and distributors are urged to make classroom films available, at the earliest opportunity, in 8mm sound editions. Special emphasis should be placed on solving the problems of manufacturing high-quality, low-cost release prints and in developing a mass marketing setup capable of bringing about a significant reduction in the ultimate price of prints to schools

30. Information-storage-and-retrieval systems for the school library:

To date, prime emphasis of information-storage-and-retrieval experts has been devoted to large archives. Now the principles of documentation should be applied to solving the far less pretentious, but inherently no less deserving, needs of the individual high school or even elementary school library.

31. Creativity stimulus in students calls for novel apparatus:

The Conference placed great stress on the fact that, in our push to develop an educational technology, we should not let our enthusiasm for instruments of didactic presentation obscure the need to find other devices designed to foster the student's initiative and creativity.

32. Underdeveloped countries need efficient, simple AV tools:

As the United States takes on increased overseas responsibilities, implicit in its audiovisual leadership is the task of devising efficient, simple AV tools designed to fit the needs of the underdeveloped countries. Happily, such devices -- because of this simplicity -- often end up by having domestic U.S. marketability.

33. Closer ties with Space Age technologies advocated:

Two Conference participants were already the designers of earth satellite tools: Dr. Maurer, a film camera; Mr. Cousino, a tape recorder-reproducer. Space Age demands for extreme miniaturization may have the happy by-product of supplying the drive and the money to give to education some of the exotic hardware it covets.

A Systems Approach To The Teaching-learning Process

34. Thorough probing of the "systems approach" is recommended:

In view of the ever-growing complexity of educational problems, as well as a like trend in the tools to solve them, the Conference recommended that full investigation and pilot experiments be conducted as to the potentialities of the systems approach to the teaching-learning process.

35. R & D contracts, U.S. government supported, urged for systems?

Whether the government should award contracts for research and development by specialists to help education should be the subject of future study by a task force. These specialists would be chosen for their competence in teaching audiovisual methods and systems.

36. Fads in education deplored; value of the practical stressed:

There are fads in education as there are in women's hats. Educational fads -- the new for the sake of newness -- are to be deplored. Educators were cautioned to avoid becoming too committed to any one instructional medium. They should choose the best tool for the particular job.

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37. School libraries and AV functions should be more closely linked:

The respective functions of the school librarian and of the building audiovisual coordinator will have to be re-examined. Instructional materials and systems philosophies eventually mean integration of book, film, other media.

38. Computers open up executive training methods:

It was suggested by the Conference that simulation -- both in the military game and computer sense -- should be used in training those individuals who have the responsibility of making top educational decisions. For example, school administrators should be given the benefit of training in decision-making via computers.

39. Instructional equipment systems -- their personnel needs:

Educational authorities will come to recognize that they will have to provide personnel of high competence to devise, install, and operate the new systems of instructional equipment now being envisioned.

40. Teachers too must be retrained to handle the systems approach:

It is important to instill staff enthusiasm for the instructional equipment systems approach when introducing it. This means in-service training of teachers to make effective use of such systems. (The hardware won't work all by itself).

41. A new profession: a teaching-learning systems specialist:

Development of highly competent teaching-learning systems specialists was forecast and endorsed. These experts would be trained to diagnose the curriculum and instructional needs of schools, apply the best technological solutions in the light of local requirements.

42. The proper role of AV should be brought home to the public:

Participants expressed their conviction that there is a basic need for a broad public relations program to explain to the public the vital role which audiovisual technicians can play in bettering America's education.

43. Thanks expressed to the SMPTE and to the USOE for the Conference:

And in conclusion, the participants extended a vote of thanks to the SMPTE and to the USOE for having pioneered in convening a conference cutting across the fields of science, industry, and education to consider in overview, "Needs For, and Developments In, Audiovisual Devices Suitable for Educational Uses."

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PART SIX

ABOUT THE PARTICIPANTS

PARTICIPANTS

- - - About the Authors

MR. JOHN FLORY is advisor on non-theatrical films for the Eastman Kodak Company. Formerly with Paramount Studios, he later became president of Flory Films, Inc., chairman of the Audiovisual Committee of the Association of National Advertisers, vice-president of the University Film Foundation, national Chairman of CINE (Committee on International Nontheatrical (Film) Events). A graduate of Yale University, he is active in numerous film and audiovisual organizations embracing the educational and business fields; the producer of many business, educational, and television films; contributor to various technical journals; and editor of a book on business films.

DR. WILLIAM H. ALLEN is director of research, Department of Cinema, University of Southern California. He is editor of AV Communication Review, which is the research quarterly of the Department of Audiovisual Instruction, National Education Association. Dr. Allen has also been a special consultant in educational television for the California State Department of Education. He was advisor on communications and psychologist to the RAND Corporation and the Systems Development Corporation, Santa Monica, California. He has contributed to the Encyclopedia of Educational Research and has served as consultant to the U. S. Office of Education on phases of the Title VII NDEA program.

- - - About the Collaborators

MR. WARREN F. ALBRECHT is manager, product planning, of the Photo Lamp Department, General Electric Company, Cleveland, Ohio. He is an honor graduate in electrical engineering from Rose Polytechnic Institute in Terre Haute, Indiana, where he was elected to Tau Beta Pi. Since 1949 he has been with the General Electric Company, starting as a test and development engineer. He has had wide experience in many phases of lamp development as it affects the photographic and audiovisual fields. He is the holder of six patents.

DR. CHESTER D. BABCOCK is assistant superintendent of the Washington State Office of Public Instruction. He attended Whitman College, Washington State University, the University of Oregon, and Stanford University. Dr. Babcock's recent books are, American Values and Problems, Administering Curriculum Planning, and Exploring Our Pacific Northwest. He has contributed to many professional journals and is a consultant to a number of educational publishers. Dr. Babcock is currently president (1962-63) of the Association for Supervision and Curriculum Development, is a member of DAVI-NEA and NCSS, and serves on the advisory board of the NEA Study on Technology in Education.

DR. FRANK BARRON is research psychologist at the University of California, where he received his Ph.D. He has been a guest lecturer at Harvard University. Dr. Barron's research has been primarily in four areas of work: psychotherapy, aesthetics, and psychology of religion, and creativity. He is currently writing a book on creative writing, and editing a book of papers on Early Identification of Creative Scientific Talent.

MR. JOSEPH BOON is technical assistant to the general manager of the Apparatus and Optical Division at Eastman Kodak Company. Mr. Boon received his bachelor's degree from Southern Methodist University and his master's degree from the University of Illinois. He has been with the Eastman Kodak Company since 1929. Mr. Boon serves in an advisory capacity on matters concerning commercial and military activities, and has responsibility for photo-systems planning for the Apparatus and Optical Division.

DR. C. R. CARPENTER is professor of psychology and director of the Division of Academic Research and Services at the Pennsylvania State University, University Park, Pennsylvania. He has organized and directed eight years of work under the Instructional Film Research Program, which has developed research methodology and equipment and has issued sixty-six technical reports. He is presently the organizer and director of an Instructional Television Research Program at the University. This includes programming and instrumenting Basic Mathematics and Basic English for presentation by closed-circuit television, and testing large-screen TV projection.

MR. BERNARD COUSINO, president of Cousino Electronics Corporation, Toledo, Ohio, graduated from the University of Toledo, and did graduate work at Columbia and Notre Dame Universities. His firm manufacturers audiovisual devices for both education and business and specializes in tape cartridges, recorders, reproducers, and continuous-loop tape mechanisms, including items for the National Aeronautics and Space Administration space satellites. A past president of the National Audio Visual Association, Mr. Cousino is currently chairman of the education committee of the Magnetic Recording Industry Association.

MR. JOHN DOSTAL is owner of Educational Electronics Sales, Garden City, New York. His firm is concerned with the design, sales and installation of electronic classrooms and language laboratories. He is also president and director of Electronics for Education, Inc., which is currently organized to produce and market a testing machine in the educational field. Prior to establishing his own firm, Mr. Dostal was with the Sound and Audio Visual Products arm of RCA as marketing manager. He is a member of more than a dozen leading trade, educational and technical societies.

DR. JAMES D. FINN, professor of education at the University of Southern California, is also chairman of the USC Department of Audio-Visual Education and acting head, Department of Cinema. During World War II he served as chief, Instructional Aids Services, Command and General Staff School, Fort Leavenworth. Author of more than forty publications on education and audiovisual theory, Dr. Finn is a past president of the Department of Audio Visual Instruction, National Education Association. His current projects include supervising a major research study on AV usage for the U.S. Office of Education.

DR. LOUIS FORSDALE, professor of English, Teachers College, Columbia University, is also research associate, Horace Mann Institute of School Experimentation. There, as coordinator of the Interdepartmental Program in Communication and the Communication Arts and head of the Project in Educational Communication, he has authored numerous articles and co-edited Communications In General Education. Recently, he arranged and chairmaned at Teachers College the first national conference on 8mm Sound Film In Education, proceedings of which were published under his editorship as the book, 8mm Sound Film And Education.

DR. ROBERT M. HAYES is president of Advanced-Information Systems Company and vice-president and scientific director of the Electrada Corporation. He was formerly head, Business Systems Department, Magnavox Research and Development Laboratories. Dr. Hayes took his Ph.D. in mathematics at U.C.L.A. There, as well as at American University, he has lectured on mathematics, numerical analysis, computer usage, and information storage and retrieval. Dr. Hayes, one of the country's leading experts on systems, is an editor of the Journal for the Association of Computing Machinery and U.S. regional editor of the international journal Problems in Information Storage and Retrieval.

MR. RAYMOND G. HENNESSEY is division manager of the Industrial Products Division, Fairchild Camera and Instrument Corporation. A graduate of Polytechnic Institute of Brooklyn, where he took his degree in electrical engineering, Mr. Hennessey has had wide experience in the areas of equipment design, manufacturing, and marketing. A member of SMPTE, the Audio Engineering Society, the Photogrammetric Society, and other professional organizations in the photographic and electronics industries, he has contributed articles to leading electrical engineering journals. His recent assignment at Fairchild has made him an active pioneer in 8mm sound film.

MR. B. WILLIAM HENRIKSON is manager of research and development, American Seating Company. Prior to joining them 12 years ago, he was chief engineer, Keystone Manufacturing Company, and, before that, chief product engineer, Ansco Division, General Aniline and Film Corporation. Mr. Henrikson is responsible for the design, development, and testing of all American Seating's products -- for schools, churches, theaters, and auditoriums, buses, stadiums, hospitals as well as electronic devices. He belongs to the American Society of Mechanical Engineers and the American Ordnance Association.

MR. THOMAS W. HOPE, assistant advisor on non-theatrical films for Eastman Kodak Company, is an authority on the statistics of the audio-visual field. A graduate of Texas Western College, during World War II he trained combat cameramen and served as an Army photographic officer. For eight years he headed the film department at General Mills, Inc. Mr. Hope is a member of UFPA, SMPTE, IFPA, and a trustee of the Committee on International Nontheatrical (Film) Events. As a member of the AV Committee of the Association of National Advertisers, he authored several of their publications. He was a charter member and first vice-president of the Industrial Audio-Visual Association.

MR. RICHARD B. HULL is executive director, Ohio State University Telecommunications Center at Ohio State University. He has attended Iowa State University, State University of Iowa and Oregon State College. A nationally recognized leader in educational television, Mr. Hull was a director (1953-60) of the Educational Television and Radio Center; a member (1952-57) of the U. S. National Commission for UNESCO; U. S. TV representative to UNESCO, Paris (1952, 1956); a member of the National Advisory Committee New Media, U.S.O.E.; chairman, Ohio Governor's Commission on Educational TV; chairman of the board, National Association of Educational Broadcasters.

MR. W. MAC LEAN JOHNSON is president of the Webster Publishing Company, St. Louis, Missouri, publishers of educational texts, workbooks, and audiovisual materials for primary, elementary, and secondary grade levels. He received his bachelor's degree from Amherst College, his master's in education from Columbia University. During World War II, he was decorated with the Bronze Star while serving as a photographic and newsreel officer. Mr. Johnson is a leader in the American Textbook Publishers Institute, an association of textbook publishing houses, having served on its board of directors, and as secretary in 1959-1960. He also is a member of the American Institute of Graphic Arts and the American Association of School Administrators.

MR. HUMBOLDT W. LEVERENZ is associate director of RCA Laboratories, Princeton, New Jersey. He received his bachelor's degree from Stanford University, studied physics and chemistry as an exchange fellow at the University of Münster, Germany. Mr. Leverenz is internationally known for his research on luminescent and other electronically active solid materials, furthering fluorescent lighting techniques and the development of efficient phosphors for kinescopes for black-and-white and color television. Over 60 patents have been issued on his inventions. He is the author of numerous scientific and technical articles and of the book An Introduction to Luminescence of Solids.

MR. JOHN A. MAURER is president of JM Developments, Inc., New York City. A pioneer in the field of 16mm sound, he, as much as any single individual, has been responsible for developing the technology of direct 16mm sound recording. A graduate of Western Reserve University, Cleveland, Ohio, which awarded him the honorary degree of Doctor of Science in 1953, Dr. Maurer has numerous patents to his credit. He has contributed many papers to the journals of SMPTE, SPSE, Opt. Soc. of Amer., Acoustical Soc. of Amer., N. Y. Microscopical Society, and others. During World War II, he was the recipient of special awards from the Secretaries of the Army and the Navy for excellence of work done for OSRD and Navy Ordnance.

MR. JAMES M. MEAGHER is coordinator of audio-visual instructional materials, Penfield Central Schools, Penfield, N. Y. He received his bachelor's and master's degrees from State University Teachers College, at Geneseo, N. Y. Technical advisor on Eastman Kodak Company's motion picture *Pictures Teach at Penfield* he has written for *The Instructor*, *Educational Screen*, and others. He has served as AV editorial consultant to Graflex, Inc. In 1953 he was awarded a fellowship for research study in cinema and television by the Fund for the Advancement of Education, Ford Foundation. Mr. Meagher is a member of the N. Y. Teachers Association, N. Y. AV Council, DAVI, and past president, Rochester Audio Visual Association.

MR. S. C. PEEK, is manager of applications and development engineering for Sylvania Lighting Products, a subsidiary of General Telephone and Electronics Corporation. Prior to assuming his present position in 1948, Mr. Peek was president, Seminar Electric Pan Electroflash Company. He graduated in electrical engineering from the Massachusetts Institute of Technology. He has written on the subject of projection light sources and is a member of the Institute of Radio Engineers and of the Illuminating Engineering Society.

MR. BEN PEIREZ is secretary-treasurer of Viewlex, Inc., Holbrook, Long Island, leading manufacturers of filmstrip projectors and other audiovisual apparatus. To the audiovisual field he brings a wide background in many facets of motion picture equipment, design, and marketing. A lecturer at the National Institute of Audio-Visual Selling, Indiana University, Mr. Peirez has also lectured at the National Photographic Institute. A supporter of numerous projects fostering the growth of the audiovisual industry, he has also been active in the National Audio-Visual Association and in working with DAVI-NEA.

DR. CHANDOS REID RICE is assistant to the Superintendent in charge of Curriculum for secondary and elementary schools at Waterford Township Schools, Pontiac, Michigan. She is also chairman, Commission on Instructional Materials, Association for Supervision and Curriculum Development, and director of the ASCD Project on Developing a Theory of Instructional Materials. Dr. Rice, a graduate of the University of Colorado, took her Ph.D. at Northwestern University. She was a Fulbright lecturer in India and has worked as consultant and cooperative researcher in public school programs in New York City; Battle Creek, Michigan; Kansas City, Missouri; Philadelphia, Pennsylvania; and Springfield, Missouri.

MR. ALBERT J. ROSENBERG is vice president, McGraw-Hill Book Company, where he was instrumental in establishing their successful Text-Film Department, a pioneer instance of a textbook publishing house diversifying into educational motion pictures and filmstrips. Mr. Rosenberg studied at Carnegie Tech, New York University, Johns Hopkins, and the University of Maryland. His master's degree in aeronautics and graduate work in education fitted him to supervise the U.S. Office of Education's famous World War II series of aircraft construction film and AV packages. He is a member of the National Audio-Visual Association, New York Film Council, DAVI-NEA.

DR. HERBERT SCHUELER is director of teacher education and chairman of the Department of Education at Hunter College, N. Y. C. He has studied at C.C.N.Y; the University of Berne, Switzerland, and N. Y. University Graduate School of Arts and Sciences. He has co-edited several books, including The Encyclopedia of Modern Education and Practical American English. He has written articles for such publications as Journal of Higher Education, Adult Leadership, Journal of the Association for Education by Radio, and German Quarterly. Dr. Schueler, a former Blumenthal Fellowship recipient, later served as a U. S. specialist in Germany under the auspices of the U. S. Department of State.

MR. JOHN W. SERVIES is vice president of National Theater Supply Company, a Subsidiary of General Precision Equipment Corporation. He has been president of the Society of Motion Picture and Television Engineers. A graduate of Wabash College, he did postgraduate work at Northwestern University. Mr. Servies' many years of experience in the motion picture theater equipment industry have made him familiar with the trade factors involved in the engineering, manufacturing, and marketing of film equipment. He has been active in SMPTE activities dealing with screen brightness and projection practices. As president of the Society, he encouraged closer liaison between educators and equipment engineers.

DR. SETH SPAULDING, formerly chief, Educational Research and Services Section of the Educational Media Branch, U.S.O.E. is now Associate Professor at the University of Pittsburgh School of Education and Graduate School of Public and International Affairs. Dr. Spaulding has received degrees from Mexico City College and Ohio State University. As senior advisor, Overseas Development Program of the Ford Foundation, he spent five years in the Middle and Far East, particularly Burma. Prior to that he served as fundamental education program specialist with the Pan-American Union. Dr. Spaulding has had articles published in Audio-Visual Communication Review, Educational Research Bulletin, Fundamental and Adult Education, Institute of International Education News Bulletin, and others.

COL. CHARLES S. STODTER is executive secretary of the Society of Motion Picture and Television Engineers. A graduate of the Massachusetts Institute of Technology, he holds a master's degree in electrical engineering. Prior to joining SMPTE in 1956, Col. Stodter was senior research investigator with the Institute for Cooperative Research, University of Pennsylvania. At the time he retired from the U. S. Army in 1954 after 30 years of service, he was chief, Army Pictorial Service. He administered all army pictorial activities during the Korean War, including still photography and motion pictures and television used for training and other military purposes.

DR. C. WALTER STONE, formerly director, Educational Media Branch, U.S.O.E., is now director of the Center for Library and Educational Media Studies, University of Pittsburgh. At Columbia University he took his A.B., B.S. in library science, M.A, and Ed.D. He served in the U. S. Navy during World War II, and thereafter with N. Y. Public Library, C.C.N.Y., Institute of Adult Education, and as professor at University of Illinois. As head of AV activities at the Detroit Public Library, Dr. Stone received a Fund for Adult Education Award in 1954, and belongs to numerous professional societies. The extensive research program under Title VII of the NDEAct was for a considerable time under his general jurisdiction.

MR. ADRIAN L. TERLOUW is educational consultant in the Sales Service Division of the Eastman Kodak Company. As an instructor, he taught at Hope College in Michigan, the University of Michigan, and Johns Hopkins University. He has an extensive research record in genetics, cytology, and biophysics. He is an Associate and Fellow of the Photographic Society of America. He is a member of the following organizations: the Education Committee of the National Press Photographers Association, the National Education Association's Department of Audio-Visual Instruction, the School Facilities Council, and the Audio-Visual Commission on Public Information.

MR. MALCOLM G. TOWNSLEY is vice president, Engineering Development, at Bell & Howell Company, Chicago. He received his bachelor's degree in mechanical engineering and his master's degree in engineering from the University of Cincinnati. His work at Bell & Howell has resulted in his becoming a leading authority on audiovisual apparatus design as applied to the fields of business, the armed services, and education. Mr. Townsley's professional memberships include the American Society of Mechanical Engineers, Optical Society of America, American Ordnance Association. He is likewise a Fellow of the Society of Motion Picture and Television Engineers and serves as a member of its board of governors.

MR. G. B. WADZECK is superintendent of schools in San Angelo, Texas. He received his bachelor's degree from McMurray College and his master's degree from Texas Technological College. Mr. Wadzeck has served as a consultant at numerous university workshops. He is a member of the Advisory Committee, State Board of Education on Educational Television and of the State Commission on Educational Television. He belongs to the American Association of School Administrators, the Texas State Teachers Association, and the National Education Association. Under his administration, San Angelo schools have attracted national attention for innovations both in curriculum and in school building design.

MR. DON WHITE is executive vice president of the National Audio-Visual Association, Inc., Fairfax, Virginia. He entered the audiovisual field in 1936 as head of the Audio-Visual Extension Service of the University System of Georgia in Atlanta. He has served as a consultant to the U. S. Department of State in its Overseas Motion Picture program; chairman, Audio-Visual Commission on Public Information; and is currently treasurer of the Educational Media Council. A registered lobbyist, Mr. White has been active in fostering constructive audiovisual legislation. He was the co-inventor of an automatic film inspection machine and is the inventor of a new electronic test-grading machine shortly to come on the market.

MR. W. T. WINTRINGHAM is visual systems research engineer for the Bell Telephone Laboratories, Inc., Murray Hill, N. J. A graduate of Harvard University, he has been active in television research since 1945, and in charge of the TV research group at the Laboratories until nearly 1956. Since, he has been in charge of visual-systems research. He is a member of the U. S. National Committee of the Commission Internationale de l'Éclairage, and a delegate for the SMPTE to the Inter-Society Color Council. Mr. Wintringham is a fellow of the IRE, SMPTE and the AAAS as well as a member of the Acoustical Society of America, and the Optical Society of America.

PART SEVEN

APPENDIXES

(Selected from among the background papers prepared for the Conference participants)

Appendix A

A TAXONOMY OF AUDIOVISUAL APPARATUS

Explanatory Note:

(The following document is excerpted and reprinted by permission from "A Report of Proceedings of an ASCD SEMINAR ON A THEORY OF INSTRUCTIONAL MATERIALS," St. Louis, Missouri; May 19-23, 1960. Conducted by The Association for Supervision and Curriculum Development, National Education Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

Under a contract with the United States Office of Education under provisions of Title VII, Part B, National Defense Education Act of 1958.

Project Director: Chandos Reid, Assistant to the Superintendent
of Schools, Waterford Township Schools,
Pontiac, Michigan.

Project Coordinator: O. L. Davis, Jr., Associate Secretary, ASCD).

Small Group Reports - Committee 2a

Members of subcommittee:
Flory, John - (secretary); advisor on Non-Theatrical Films, Eastman Kodak Company
Johnson, W. Mac Lean; president, Webster Publishing Company
Shafer, Robert; associate professor, Wayne State University
Umstattd, J. G.; professor of secondary education, University of Texas
Whitenack, Carolyn; assoc. prof. of education, library and audiovisual education, Purdue University

This subcommittee felt that a taxonomy afforded the most convenient way of analyzing the many educational materials media, their characteristics, and their relative merits.

To this end, a large chart was proposed. The media would be listed vertically, in a column. Across the top it was proposed to list characteristics and other attributes of the media. At the point where

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Appendix A

A TAXONOMY OF AUDIOVISUAL APPARATUS

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Media and Their Characteristics

This subcommittee felt that a taxonomy afforded the most convenient way of analyzing the many educational materials media, their characteristics, and their relative merits.

To this end, a large chart was proposed. The media would be listed vertically, in a column. Across the top it was proposed to list characteristics and other attributes of the media. At the point where

a specific medium would intersect with a specific characteristic, the junction square would be marked with an "x", a digit, or a descriptive word, as the case might be.

It was felt that there has never been heretofore any extensive compilation of this sort. Since subcommittee members felt that there are at least 200 well-accepted media, and an entirely unexplored number of attributes to delineate, the preparation of a reasonably complete taxonomy would be beyond the subcommittee's capabilities in the brief time allocated to it.

Therefore, it is recommended that the preparation of a comprehensive taxonomy of this type should be the subject of independent research.

It is felt that, as the differing characteristics of the various media are painstakingly described and assessed, new concepts will become apparent as the various characteristics are grouped and regrouped into families of characteristics and other multiple arrangements.

The potentiality of this approach would appear particularly fruitful as the characteristics being enumerated begin to probe the program content of the media and, more particularly, the psychological aspects of the teaching-learning process.

Following is a partial list of the media which the subcommittee compiled in connection with its discussions. (It is recognized that this is an arbitrary selection and arrangement, without any attempt at being complete.)

Preliminary List of Media

1. Teachers
2. Other students
3. Teachers' "aides" (assistants)
4. Motion pictures (sound)
4a. Motion pictures (sound) (8mm)
5. Motion pictures (silent)
6. Motion picture production (as a teaching method)
7. Television
8. Closed-circuit television
9. 2-way television (phonoscope)
10. Kinescope recording
11. Video-tape recording
12. Filmstrips (silent)
13. Filmstrips (sound)
14. 2" x 2" slides
15. 3¼" x 4" slides
16. Overhead projectors (and transparencies)
17. Opaque projectors
18. Radio
19. Telephone
20. Record players (and records - discs)
21. Tape recorders (and combination recorder-reproducers)
22. Tape recorders (and tapes)
23. Teaching machines
24. Still photographs
25. Photojournalism (picture stories)
26. Still photography (as a teaching method)
27. Pictures (drawn)
28. Cartoons
29. Comic strips
30. Three-dimensional viewers, slides, etc.
31. Chalk boards
32. Charts
33. Graphs
34. Maps
35. Globes
36. Magnetic boards (flannel boards, "hook and loop" boards)
37. Fluorescent magnetic boards (and flannel boards)
38. Signs
39. Slide (or rotating) graphs
40. Models (miniatures)
41. Peg boards
42. Blocks (and three-dimensional geometric symbols)
43. Exploded views
44. Cutaways and cross sections
45. Contour maps and globes
46. "Isotype" (pictorial statistics and symbols)
47. Mock-ups
48. "Blowups" (larger than life illustrations or models)
49. Animated displays
50. Continuous projectors (for displays)

51. Posters
52. Bulletin boards
53. Displays and exhibits
54. Analytical motion picture projectors (variable speed)
55. Cinefluorography
56. High-speed cinematography
57. Time-lapse cinematography
58. Stop-motion cinematography
59. Animation (cine)
60. Microscopy
61. "Memo-motion" (phase photos)
62. Stereo-cinematography (three-dimensional motion pictures)
63. Wide-screen and multi-screen cinematography
64. Wide-screen and multi-screen filmstrips
65. Role-playing
66. Drama
67. Pageants
68. Parades
69. Expositions
70. Fairs, festivals and carnivals
71. Competitions
72. Puppets
73. Silhouettes
74. Shadow-graphs and shows
75. Games
76. Pantomimes
76a. Prestidigitation
77. Dance
78. Sculpture
79. Painting
80. Guest lecturers
81. "Living newspapers"
82. Live animals
83. Zoos
84. Reconstructions
85. Realia
86. Books
87. Textbooks
88. Workbooks
89. Picture books
90. Comic books
91. Reference books
92. Newspapers
93. Magazines
94. Serials (other)
95. Pamphlets
96. Broadsides
97. Cut-outs
98. Tests
99. Libraries
100. Librarians
101. Microprint and "Microcards"
102. "Minicards"

103. Microfiches and aperture cards
104. Microfilm
105. Data-storage-and-retrieval systems
106. Office copiers
107. Short-run duplicators ("Mimeograph," "Ditto," etc.)
108. Tachistoscopes
109. "Perceptoscopes"
110. Laboratories
111. Microscopes, telescopes, etc.
112. Computers, comptometers, adding machines, abacuses, slide rules, etc.
113. Objects
114. Collections
115. Museums
116. Museum guides and interpreters
117. Field trips
118. Workshops
119. Architectural attributes
120. Typewriters
121. Gymnasiums, pools and playing fields

In compiling a list of characteristics of the various media, it was kept in mind that there have been several definitions of mass communications enunciated; for example:

"Who says what to whom (through what medium--or channel) to what effect."

or

"Sender---message---encoded---channel---receiver---message decoded (interpreted)."

Following is a fragmentary and heterogeneous list of media characteristics. (It was recognized that to compile a comprehensive list would be beyond the capability of this particular subcommittee).

Sensory appeals -

Eye (color or black-and-white)
Ear
Touch
Smell
Taste

Types of symbols -

Print
Speech
Still pictorial image
Moving pictorial image
Sound
etc.

Degrees of permanency -

Ephemeral
Permanent
Archival

Physical availability -

Requires no transmission or reproduction apparatus
Requires apparatus of transmission or reproduction
Very portable
Portable
Nonportable
Requires little expertise
Requires some expertise
Requires considerable expertise
Requires great expertise
(for example, to read a book involves some, or great expertise)

Degree of availability to student -

Available to student on demand, in school and/or out of school
Available to student on demand in school
Available to student out of school on demand
Available to student in school only under teacher's direction

Audience characteristics

Can be used by individual alone
Can be used by individual or group
Can be used by group
Can be used by small group only
Can be used by large group

Economic availability factors to consider -

Basic capital investment
Maintenance and replacement cost
Operating cost
Per-pupil cost
Per-pupil cost per-class period, etc., etc.

Note: The subcommittee strongly recommends that a separate seminar be held at some time in the not too distant future to delve into this crucial matter of the comparative cost of the various media.

Psychological potential
Does the medium in question induce or encourage -

Motivation
Creativity and imagination
Reinforcement
Information giving
Repetition and/or practice
Insight and understanding
Attitudes
Independence (self-reliance)
Critical thinking
Skill (physical or manual)
Skill (mental)
Emotion

Note: Here the subcommittee regretted that lack of time at the Conference precluded Group 2's collaborating with the other groups to collect psychological and curricular characteristics to be added to the above list of media characteristics. The relative psychological advantages of the various media are recognized as worthy of a separate seminar.

As an experiment for its own edification, the subcommittee analyzed two media on the basis of the foregoing limited list of characteristics. For example:

Medium - Books

Sensory appeal: Sight (black and white and/or color)
Types of symbols: Print
Still pictorial image
Audience characteristics: Can be used by individual alone
Economic availability: Very high
Degree of permanency: a) permanent, b) archival, c) ephemeral
Physical availability: Requires considerable or great expertise
Requires no transmission apparatus
Very portable

Degree of availability to student: Available readily on all counts - in school and out - particularly in case of textbooks

Psychological potential: All attributes, in positive or negative degree, depending on specific title in question

Medium - Motion Pictures - Sound

Sensory appeal: Sight (black-and-white and/or color)
Types of symbols: Moving pictorial image
Sound and speech

Degrees of permanency: Permanent
Physical availability: Requires apparatus of transmission
Portable
Requires little expertise
Degree of availability to student: Available to student(s) in school only under teacher's direction
Audience characteristics: Extremely flexible. Can be used by individual alone or in groups of from 2 to hundreds or even thousands simultaneously
Economic availability: Medium to inexpensive
Psychological potential: Motivation - 90%
Creativity - 70%
Reinforcement - 70%
Information giving - 90%
Repetition - 40% and up
Insight and understanding - 90%
Attitudes - 90%
Independence (self-reliance) - 40%
Critical thinking - 80%
Skill (physical) - 50%
Emotion - 90%

Appendix B

THE CRITICAL PROBLEM OF ACCESSIBILITY OF MATERIAL

by

Louis Forsdale
Professor of English, Teachers College
Columbia University

Communication technology has two great jobs with respect to education. The first job is invention of new media, or instruments; the second job is the constant refinement of these instruments to improve their quality and make them ever more accessible to teacher and learner.

The past century has been a most fertile one in providing new media of communication--still photograph, telegraph, telephone, motion picture, radio, television, and all of the associated devices which make use of these basic technologies. Technical quality has also increased steadily (one had better avoid the question of quality of materials). We have also made media products more and more accessible for all to benefit from; but that job is by no means complete. I should like to sketch a theoretical framework for thinking about accessibility and discuss briefly an opportunity which lies ahead to increase the educational accessibility of motion pictures.

Media Begin With the Few, Expand to the Many

All media begin in the hands of the few and are gradually made available to the many. Manuscript books were so few and so precious that they were frequently chained to reading tables in monasteries. The elite nature of the

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[1] Dr. Forsdale is also Principal Investigator of the Project in Educational Communication, Horace Mann-Lincoln Institute of School Experimentation. This paper has been shortened and brought up-to-date following the Conference.

book was altered profoundly when print with movable type was perfected toward the middle of the Fifteenth Century. But even printing did not instantly make the book available to all. Indeed, even today books are not available to all, but the tendency toward democratization of print has been dramatic.

Photography also began in the hands of the few. Even Dageurre, who saw both the artistic and commercial possibilities in photography, did not place either cameras or prints in the hands of the masses. It took George Eastman's vision to give all of us Brownies or their latter-day descendants. The direction was from the few to the many.

One could continue to muster evidence to support the proposition that media--whether in society at large or in education--begin in the hands of the few and only gradually become accessible to the many. But let us consider that case made, and move on to consider implications.

The Importance of High Accessibility

A prime criterion of the worth of any packaged educational material is its availability to the learner when and where and as often as he needs it. Materials which do not meet this criterion, whether for technical or financial reasons, are less than ideal. Notice that I said "less than ideal," not "no good," for there are other criteria too, which should be applied to educational material: interest to the learner, aesthetic quality, accuracy, cost, and so forth.

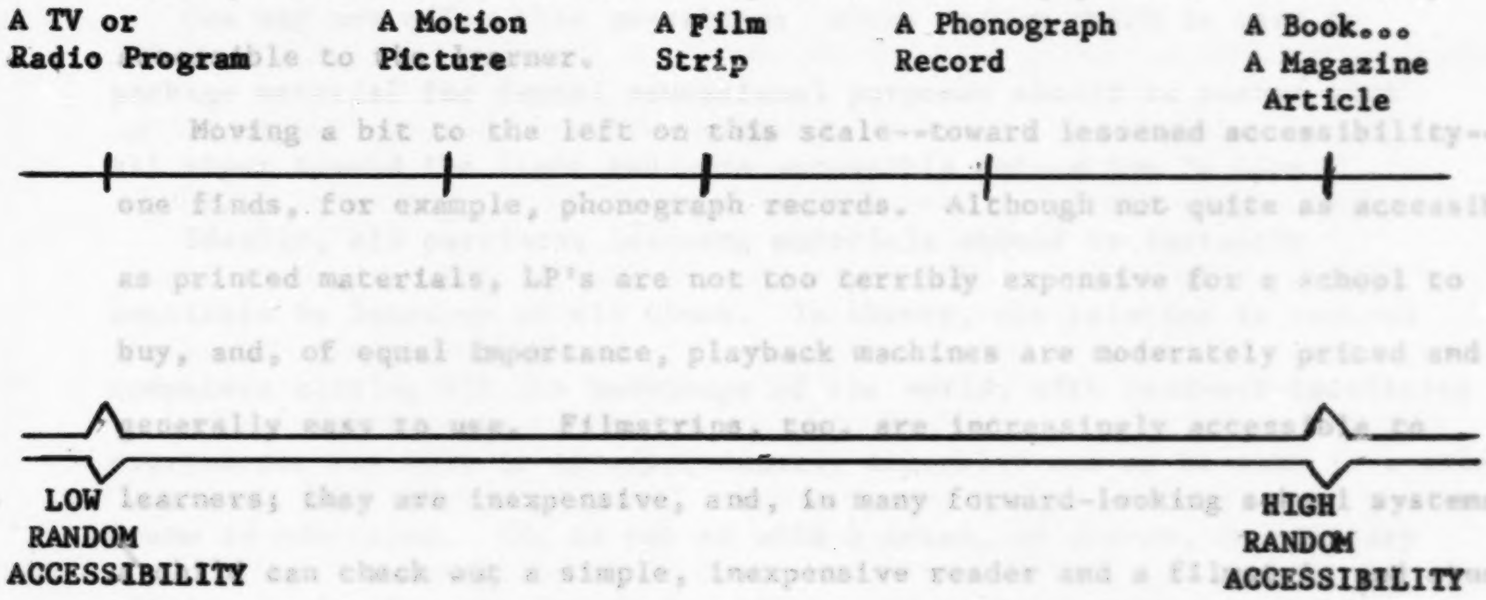
One way of illustrating the accessibility of materials is by means of a device which I call the "A Line." "A" stands for "accessibility." An illustration of the "A Line" appears on the following page.

The "A" Line"

The right end of the "A Line" stands for high accessibility of materials to the learner. If materials are readily, and randomly, accessible to the

The "A" Line

Indicating Random Accessibility of Materials to Learner


A TV or Radio Program
A Motion Picture
A Film Strip
A Phonograph Record
A Book...
A Magazine Article
LOW RANDOM ACCESSIBILITY
HIGH RANDOM ACCESSIBILITY

student, they are placed toward the right end of the line. On the other hand, if the student has little or no choice over what materials are available to him, and when, they are placed at the left end of the line, this represents inaccessibility.

What materials should we place at the right end of the line--the end of high accessibility? Clearly books go there, for, of packaged materials in our educational system, books are probably the most readily accessible to the user. Textbooks are checked out and retained for long periods; books are available in the library or the student bookstore; and thousands of paperback titles are available in magazine and drugstores. Furthermore, the book requires no intermediate machine to "read out" the material. Other printed materials such as magazines and newspapers are also easily accessible to the learner.

Moving a bit to the left on this scale--toward lessened accessibility--one finds, for example, phonograph records. Although not quite as accessible as printed materials, LP's are not too terribly expensive for a school to buy, and, of equal importance, playback machines are moderately priced and generally easy to use. Filmstrips, too, are increasingly accessible to learners; they are inexpensive, and, in many forward-looking school systems, a child can check out a simple, inexpensive reader and a filmstrip and study it at home or at school.

What goes at the extreme left end of the "A Line"--at the end of least random accessibility to the student? The prime offender in terms of the criterion which I have set up here is broadcast television. The learner has no control over what program will be delivered when, and he cannot choose to see it again. True, a given program is accessible in the sense that the television set is simple to operate and is widely available, but still one cannot choose to see a program which is not on the broadcast schedule. It has been noted before that television is a train, operating on a track on a schedule. It gets you where the tracks go, when the train comes. As a train, it has advantages: one avoids the bother of handling the vehicle, and it probably costs less to handle masses of people.

Film also falls near the inaccessible left end of the line, both because our expensive films are carefully locked in centralized vaults and because our projectors are too few and too complicated for all but the highly motivated and trained to operate. But for all this, film has been more like a bus, with a measure of flexibility about it both in route and schedule.

Technology Should Help Increase Random Accessibility

One may now offer this assertion: every medium which is used to package material for formal educational purposes should be pushed with all vigor toward the right end--the accessible end--of the "A Line."

Ideally, all pertinent learning materials should be instantly available to learners at all times. In theory, the solution is central computers storing all the knowledge of the world, with read-out facilities everywhere, but this is so exhorbitantly expensive now as to make it a wild dream in education. (It is not so wild a dream, of course, in military affairs.) So, for the immediate future, one probably must concentrate on increasing accessibility of materials using traditional instruments.

Moving Images Can Be Made More Accessible

The distribution of instruments on the "A Line" is provocative at many points, but one of the most striking features is the relative inaccessibility of moving images via television and motion pictures. This lack can rapidly be remedied through technology which is immediately within our grasp, to some extent in the television field, and to a much greater extent in film. Let us consider these possibilities briefly.

The television technology which will make programming more closely under the control of the individual school, the individual teacher and the individual learner is, of course, video tape. Most observers of the video tape scene are aware that costs of recording and playback machines have come down in a decade from about $50,000 each to around $15,000. This means that tape machines are somewhat more accessible to individual schools, and, because of that, that greater flexibility in the use of video recordings, drawing upon a growing stock of tapes deposited in the school, is possible. This can help bring TV further across the "A Line." It is improbable in the extreme, however, that video tape machines can soon put TV at the far right end of the line, which would permit random accessibility of materials by individual learners, as well as by teachers of groups as a whole. Cost aside, it is doubtful that video tape playback machines in the immediate future will be simple enough to operate for an elementary school child to load himself.

What is occurring in the motion picture field, on the other hand, is likely to help move that medium very much closer to the "high accessibility" end of the "A Line." I refer to current developments in 8mm film. Accessibility of a medium to a learner, as has been pointed out, depends on two things: (1) low cost of the product (equipment and materials), (2) absence of a "read out" device or great simplicity of operation in the case where one is required. 8mm motion pictures promise important advances in both of these areas, as compared with traditional 16mm systems in the United States. 8mm print costs can be lower than 16mm costs, particularly if we can move to a stage of thinking where "mass" is a key term--mass runs of prints and new distribution techniques which accent selling prints at lower profits per unit and with minimum sales overhead.

But perhaps the most striking contribution which 8mm can make to accessibility of motion pictures is the simplicity of certain projectors which already exist for 8mm and which will grow in number and type. The Technicolor silent cartridge-loading projector is so simple that a four-year-old child can use it. While I have not tested the Fairchild Mark IV cartridge-loading sound projector with children, I think it is a fair guess that a six-year-old could use it without difficulty. The new channel-loading 8mm sound projector which has been brought to prototype stage by the American photographic engineer, John A. Maurer, while more difficult to use than a cartridge-loading machine, is nevertheless much simpler to operate than our standard motion picture projectors, and it has advantages in certain respects over the cartridge machines.

These new motion picture projectors can make an enormous difference in the accessibility of films in education. There is much more to be said about the pros and cons of introducing an 8mm film system in education, of course, but it is not the purpose of this brief discussion to consider other than the accessibility factor.

The printed word will probably retain its edge in accessibility for some time. We must be alert, however, to all opportunities to improve the accessibility to learners of materials from all other media. Communication technology has no greater contribution to make in education.

Appendix C

THE ROLE OF THE SYSTEMS MAN
IN THE AREA OF EDUCATIONAL MACHINES

by

Robert M. Hayes
President, Advanced Information Systems Company
(A Subsidiary of the Electrada Corporation)

The fact that this Conference is being held is a reflection of the vital importance of several programs for the solution of some critical problems in education. The need to develop a population which is better educated and better able to use its free time is coupled with the increasing needs in technology for trained personnel in the operation and control of complex equipment.

In many cases, the extreme need for trained personnel coupled with the enormously increased complexity of the decisions which they must make and the speed with which they must make them has caused a breakdown in traditional methods of training.

The search has therefore been underway for more effective solutions, particularly in the use of mechanical equipment. There now seems to be available a broad variety of such "teaching machines" to aid in the solution of these educational problems. There is a growing need for understanding of how these tools should be used.

This combination of vitally important problems with tools and techniques which appear to provide a solution has therefore resulted in a veritable explosion of activity to find the proper matching of the tools to the problems.

Unfortunately this area is so new that there is presently no integrated capability for finding solutions. No one man, no one group, simultaneously understands the educational problems, the new mechanical tools, and the techniques for matching the two.

An alliance of diverse groups is therefore necessary, and there is thus a great need for defining the proper role and responsibilities for each of the groups which must contribute to the solution of these problems.

I would like to distinguish three areas of responsibility.

The first is that of the teacher for the specification of educational and training requirements in terms of his pupil's needs; the second is that of the supplier of equipment including engineering, manufacture, and sale; and the third is that of the systems men who must provide the programs and equipment configurations for the proper matching between the two.

Of these, perhaps the most important is that which determines the requirements of the teacher.

If teaching needs are to be met effectively by an information system, they must be well defined and some measure of their relative importance must be provided.

This then can be considered the area of responsibility of the teacher, since only he is really in a position to provide the information concerning his needs; only he can weigh their relative importance.

This brings up the second area of responsibility, since modern education and training are likely to become increasingly dependent upon some degree of mechanization.

The design, construction, and sale of equipment has therefore become a dominant consideration. This responsibility of the supplier of equipment is quite well defined, well understood, and well executed. The engineer, the manufacturer, and the equipment salesman must each perform his function or face the harsh realities of modern competitive industrial life.

The proper matching of the capabilities of technology with the functional specifications on equipment -- including proper design, attention to manufacturing limitations, and assurance of marketability -- this matching is essential to the successful supplier of equipment.

This brings us to the third area of responsibility -- that of providing the proper matching of teaching needs with equipment limitations. The development of adequate programs, systems of operation, and equipment configurations becomes a critical problem when large degrees of mechanization are involved. In contrast to educational systems completely dependent on individual teacher judgment, the use of mechanization requires a detailed specification of every minute step in the training procedure.

Where the teacher can operate successfully with a minimum of predefined teaching steps, machines will not operate at all.

In addition, and equally important, the costs of mechanization are so great that the training programs must not only be specified in detail, they must also be efficient.

Again, where the teacher and pupil together can perform reasonably well under less than optimal conditions, machines are hopelessly uneconomic under such conditions. This area, then, can be considered the responsibility of the system designer.

Appendix D

THE ROLE OF TEXTBOOK PUBLISHERS
IN
EDUCATIONAL CHANGE

by

W. Mac Lean Johnson

President, Webster Publishing Company

It must be evident to all who are working in the field of education that the purpose of our schools is undergoing a thorough national rethinking. It is equally sure that the goals of education in the United States will be redirected as rapidly as possible to superior intellectual attainments for all children. Recently James E. Russell, secretary of the Educational Policies Commission, the most powerful philosophical spokesman for the educational profession, summarized for American textbook publishers the central conclusion of a significant Commission report. The central purpose of the school, said Mr. Russell, "is to teach the power of rational thought." Schools exist to develop the ability to think.

Keeping in mind that people are individuals, with greatly differing capacities and interests, it is evident that to succeed in this goal a great many changes in our practices must be made as rapidly as possible, and that techniques for matching instruction to individual need and capacity must be vastly improved.

We know that great changes in content are on their way. The various N.S.F. and N.D.E.A. sponsored curriculum studies are obvious harbingers of this future.

Equally important are methodological changes. The most obvious, of course, is the official sponsorship given to the audio-lingual method of teaching foreign languages.

Working as I do daily with the planning, design, and creation of instructional materials, I can see an equally significant but more subtle change evolving in the organizational structure of educational communication, in the style in which information is presented.

Equally important to all of us is the practical fact that all change will come, and any increase in the effectiveness of instruction, must be directed by the existing national teaching staff, with its existing level of professional competence, and with ever-increasing numbers of students to be taught.

This poses enormous difficulties, and doubtless explains well-financed panacea claims offered on behalf of new communicative devices, such as television and teaching machines.

None of these, in and of itself alone, can be expected to solve all our difficulties. This is true simply because, while each has certain strengths or qualities useful to teaching, all have distinct limitations. This statement is true for every educational device and for every medium of communication known to us today.

On the other hand, by making intelligent use of all media, and all the various devices so far created, we can make a major breakthrough in teaching power. Instructional materials, planned and properly related, can bring about a greater measure of improvement, in a shorter period of time and at a lower cost, than any other single educational undertaking possible for our nation today.

The fundamental key to significant improvement in educational outcomes lies in increased ability to adapt instruction to individuals. We must improve our techniques for presenting appropriate material to each child, and to pace increasing difficulty and complexity to the individual's rate of learning.

We don't really need to wait for vast educational experiments to accomplish this. We already know more about how to do it than we're using. I have seen in use flexible arrangements of printed materials that permit each child in a classroom to advance in reading as rapidly - or as slowly - as his nature will permit. The device was simple in administration, provided for quite adequate checks on achievement, and took less teaching time than the traditional group-teaching approach.

The 8mm sound film makes it possible, certainly, to use the motion picture as an individual learning device. A simple, inexpensive sound viewer with an appropriate headset can convert film from a relatively inflexible, mass teaching device into a highly flexible learning instrument.

However, we cannot maximize the power of instructional materials unless we use all media and devices available, and orchestrate them so that each contributes to the achievement of a specific learning goal, that element for which it is best suited by its nature.

The physics program of learning materials sponsored by the National Science Foundation is one example of a pioneer effort to do just this.

There are certain fundamental preconditions which must exist before an intermedia instructional materials system can be successfully devised.

First is the identification of a specific, clear-cut educational goal. There must be complete clarity of purpose.

Second, central planning and direction must be provided. Film planning, book planning, program planning cannot successfully focus upon a specific objective without centralized direction.

Third, teamwork is essential. Media and communications experts must cooperate closely with scholars and classroom teachers. Mere co-existence is not enough.

Fourth is increased knowledge of the best relationships of media interpreted in terms of reaching specific educational objectives. Virtually no research exists in this area, and one of the most serious defects of the NDEA '58 was its failure to provide funds and direct activity to the investigation of essential medial qualities and effective media relationships. Mr. Edward Booher, president of the American Textbook Publishers Institute, had this to say to the Subcommittee on Education of the Senate Committee on Public Labor and Welfare:

> "All educational authorities now agree that the well-equipped teacher must have available for use a range of educational materials, confined to no particular physical form or other characteristics. Textbooks, supplementary library books, encyclopedias, maps, charts, globes, classroom periodicals, tests, teaching films, television, teaching machines, and other media not yet even devised all have or will have their places. They need to be used in varying combinations depending on the subject and even the particular unit being taught, the size of the class, the grade level of the students, the classroom situation. We need to know a great deal more than we do about how to use these various media together; how to use television to stimulate reading, how to pair textbooks with teaching films, how to use encyclopedias to bridge the gap between various subject matter areas, how filmstrips and recordings can be correlated with books to enrich and enliven a course in American history. The articulation of these media into integrated systems of instructional materials for more effective learning and for better teaching is one of the most important tasks facing American education today."

Despite the lack of real knowledge of media strengths and limitations, the textbook industry is proceeding, and will proceed, at present on a best-judgment basis, to further the development of intermedia systems of educational materials.

Of all the groups active in the creation of learning materials, the textbook industry is the best prepared to undertake such a task, and it is the only group so engaged that has shown an understanding of the national need for the creation of systems of interrelated educational materials.

For example, in February of 1959, the industry's New Media Committee met right here in the Princeton Inn with leaders in film and educational TV development, with officials of the National Science Foundation, and pioneers in the development of government-sponsored curriculum-improvement programs. We listened. We wanted their advice, to learn how our industry could best proceed to supply a national need. In 1959 and again in 1960 the industry sponsored management conferences devoted to an exploration of every medium of communication available for the transmission of instructional material, and had as its "faculty" national leaders in each field. In 1961 the industry again sponsored a management conference, this one to explore the nature of the teaching-learning process itself.

That these conferences were held at all is significant. More important, the key planning and policy-making executives of virtually every educational publishing house in the country were present at all of these conferences.

Significant in the trend of publisher planning today is the activity underway now in many publishing houses to create programmed materials adaptable to teaching machines, and the establishment in 1960 by D. C. Heath and De Rochemont Films of a new firm created to produce and market intermedia materials for the teaching of foreign languages in the elementary schools.

Textbook publishers are, frankly, the only people active in educational materials development with the size and strength to finance, develop, and market intermedia systems of materials.

In 1960, industry sales of educational books reached $315 million, an increase in five years of 66% over sales of 1955. Stanley Hunt, industry statistician, predicts 1965 sales of $473 million -- which prediction, say financial analysts of Clark, Dodge and Company, is too modest. They anticipate sales of $510 million.

Industry earnings are generally high, too, thus providing the needed capital generative power to underwrite large-scale investments. Mergers in recent years have enlarged some publishers and thus established a larger capital base. Others have turned to public offerings of previously closely-held stock, thereby opening the way for future public subscription of funds to finance major ventures.

Financial strength is a vital consideration in any discussion of integrated systems of instructional materials, for these will require quite large investments of capital for their production -- many times the amount required to produce a textbook or a series of textbooks.

The textbook publishing industry has other vital strengths as well. It has superb marketing organizations in being, capable of exploring, promoting and demonstrating interrelated materials. Members firms, through their editors, field representatives and college travelers, have established relationships through all levels of the educational profession and would thus be able to bring together the scholars and teachers needed for the planning and production of interrelated materials. Some publishers, even now, have on their staffs technical specialists in the audio and visual media fields.

Right at this moment, the textbook industry constitutes a major national resource that can be directed rather quickly to the task of creating and distributing systems of educational materials.

The fact that this is possible does not mean that it will happen. There are three major obstacles which, at the moment, prevent sweeping changes or the rapid creation and use of intermedia systems of materials. Funds, in the quantity needed to purchase such materials, are not now available. Funds for the purchase of textbooks alone are not adequate to satisfy a minimal demand, and have not been since the end of World War II. Typically a student today has fewer books available to him than his counterpart had at the depths of the depression.

Funds for all other types of instructional materials are even less adequate. A survey made in the state of Ohio covering the school year 1959-1960 revealed that the average per-child expenditure for textbooks in the reporting schools was $3.97; for all other instructional materials, $5.19, making a total of a mere $9.16 per child.

Clearly, funds on such a scale are not adequate to finance a program of materials improvement. It is a reasonable assumption that systems of materials will require substantial increases in money spent for instructional materials. However, no attempt has been yet made to establish standards and guidelines for the budgeting of funds for instructional materials systems, and, until the educational profession faces up to this problem, it is unlikely that administrators, legislators and boards of education will take the steps necessary to provide increases in money for this purpose.

It seems to me there exists a strange blindness within the teaching profession to the crucial role played by instructional materials. It should be apparent that instructional materials of improved design and increased availability would be a decisive force in the results obtained. I have noted increased awareness of the crucial nature of instructional materials on the part of many educational leaders within the past three years. But it is far from becoming a forceful awareness, and I can see no evidence that professional organizations are willing to direct a significant amount of their energy to the improvement of materials, to promoting increased use of newer, superior materials, and to adequate financing of instructional materials.

Ultimately, of course, the general public must be convinced that improved and more abundant instructional materials are a major device for improving the quality of American education. The public's money must pay the bill. I rather suspect laymen generally will see the logic of the conception rather more quickly than the educational profession seems to, if it is presented to them. Somehow it must be presented, and this requires organized effort.

We can theorize, discuss, experiment and plan for all sorts of major achievements in educational materials and devices to improve their use. Unless, however, these are matched by organized, successful efforts to supply the financing required, our work will have been in vain.

Appendix E

SIMPLIFIED THEORY OF PROJECTION

by

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The object of a film projector is to illuminate a screen to a high brightness with the image of a transparent film placed at a film gate. The illumination, at the screen is approximately equal to the solid angle subtended by the objective lens, as viewed from the screen, multiplied by the brightness of the light source image divided by π provided that the objective lens is filled with the light source image. If the optics design is optimized, which it is in any well-designed

projector, the objective lens will be filled with the light source image and the film will be completely covered by light. The above requirements can be met by properly choosing the light source size and form factor, the magnification of the condensing lens or the reflector and the size of the condensing system.

Maximum efficiency can be accomplished by selecting a light source of high, uniform brightness of the minimum dimensions necessary to fill the optics as described above. It is important to realize that a point source of light will not necessarily meet the requirements. Generally speaking, the larger the film size the larger the light source must be for an optimum system.

Lamp manufacturers have recently made great strides toward the design and manufacture of bright, uniform light sources, and the result has been increased screen brightnesses with lower power requirements. Since high brightness and not lumen output is the main consideration, it is believed that lamps for projection should be rated in terms of their brightness instead of the usual lumen and wattage ratings. For this reason, the following discussion of light sources will be with this in mind.

Light Sources

The table below (Figure 2) classifies light sources in order of their brightness in foot-lamberts. It is immediately obvious that there is a tremendous range, the difference between electroluminescence and the laser being 6×10^{11}. Unfortunately, as the lamps become brighter the power supplies become bigger and more complicated. Actually, I see very little practical hope for any of the presently known light sources for projection use beyond the carbon arc in brightness. This is not to say that new inventions won't be forthcoming, but we must set some limit to our "blue sky" thinking. On the other end of the scale it appears that electroluminenscence, fluorescence and conventional mercury are of insufficient brightness to compete with the very simple and convenient incandescent. I shall, therefore, confine by discussion to incandescent, enclosed gaseous arcs such as xenon and the carbon arc.

Incandescent Filament Lamps

The tungsten incandescent lamp is amply described in many books and articles, one of which is the IES Handbook, third edition, published by the Illuminating Engineering Society, 1860 Broadway, New York 23, New York, pages 8-1 through 8-23. I shall describe here the recent developments that have made possible almost two times the screen brightnesses obtainable with 500-watt projection lamps with only 150 watts.

This was accomplished by means of a brighter, more compact filament and the placing of the condensing optics within the glass envelope. The temperature at which a filament may be run at reasonable life is dependent, in addition to other things, upon the wire size. Extensive engineering evaluation has indicated that a 150-watt filament produces optimum brightness when designed for 21.5-volt operation. This design allowed maximum wire size in a special coiled-coil helix. It also resulted in a rugged vibrationproof lamp. In order to fill the optics with such a small, compact filament it was necessary to use large magnification in the condensing system. This was accomplished by placing the filament close to an internal elliptical mirror.

This breakthrough has resulted in the use of this lamp in almost all new designs of 8mm movie projectors. Now, where do we go from here? Higher brightness filaments are still possible. This can be accomplished by continued optimization of the coiled-coil configuration, and other developments that are beyond the scope of this discussion. As these higher brightnesses are accomplished, a difficulty begins to rear its ugly head. The film and film gate gets too hot. A new development, dichroics seems to offer a good answer to this problem. If the internal reflector or condensing mirror is made of transparent material and coated with multiple layers of thin films, the infrared energy can be allowed to go out the back of the lamp with very little loss in the luminous energy that passes through the film gate. Such lamps have been made thatallow about 40% of the heat to be dissipated in this manner.

Another development seems to have promise. Lately, tungsten lamps have been available in quartz envelopes of very small diameter. Heretofore, such small envelopes blackened rapidly, because of the deposited tungsten vapor. The introduction of iodine crystals in the gas atmosphere eliminates this tungsten deposit. The small envelope

Table of Light Source Brightness

1.	Panelescent	10
2.	Fluorescent	2×10^4
3.	Mercury	5×10^5
4.	Incandescent	3×10^6
5.	Xenon Arc	3×10^7
6.	Carbon Arc	2×10^8
7.	Sun	5×10^9
8.	Atom Bomb	6×10^{11}
9.	Water Spark	7×10^{11}
10.	Laser	6×10^{12}

Figure 2.

allows the optical designer to place the lamp near the condensing system and, thereby, obtain higher magnification. This in turn results in lower wattage without loss of screen brightness. Again, low-voltage lamps seem to be superior to the line-volt variety. It should be realized that low wattage becomes important when low-voltage lamps are used because a transformer is required. The size of the transformer becomes excessive in the high-wattage versions.

Enclosed Arcs

When a gas such as xenon is ionized by a heavy electrical current, brightnesses of certain sections of the resultant arc are in the order of ten times those of an incandescent filament. Although these lamps have been manufactured for several years, they have not found much practical use in this country. However, in Europe and Japan they have recently been gaining in acceptance, in spite of the rather large power supply required to start and maintain the arc. The major difficulties have been 1) instability, 2) erratic life, 3) high cost. The color is good in the case of xenon arcs, but is unsatisfactory for color projection when other gases are used. Since it appears that some of the quality problems are being overcome, the enclosed arc should be taken seriously as a possibility for projection for large screens where high light source brightness is worth the extra expense and inconvenience of the power supply. I believe, that improvements in the lamp and power supply will continue to be realized.

Carbon Arcs

This is one of the oldest light sources known, but it is still an ideal light source both from the point of view of color and brightness.

The major difficulties are cost of operation, fire hazard, and inconvenience of electrode maintenance. At this time, licensed operators are required to run projectors using the carbon arc. There is always the chance that inventions will be forthcoming that will get around these difficulties, but developments come hard in such an old science.

Conclusion

It is my opinion that there is the greatest hope in applications such as audiovisual education in the direction of incandescent lamps. There have been recent breakthroughs in this field and great possibilities for many more. The convenience and reliability in the use of incandescence are much greater than with other light sources and economics also favor this light source.

Appendix F

AUDIO LINGUAL AIDS
TO LANGUAGE LEARNING

by

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(First presented at the annual conference of the Speech Association of America, St. Louis, December, 1960).

Anyone doubting the ascendancy of the machine as a preoccupation of teachers of language should compare a current issue of almost any one of our professional journals with one of but twenty years ago. Most striking are the advertisements: once predominantly devoted to restrained announcements of the latest textbooks, they are now largely dominated by lavishly illustrated copy extolling the newest in electronic machines and their associated furniture and supplies. The articles, too, reflect this change. In a recent issue of the Modern Language Journal, for example, all but two of the nine articles dealt in some way with the machine, either as a central or as a contributing factor to the whole.

In fact, any discussion of method in education, these days, takes place largely within a machine context. If one were to remove from the proceedings of the professional conferences held in December of 1960 any discussion or other significant mention of television, language laboratories, and so-called teaching machines, there would be little left for recorders to summarize, and our learned journals would be hard put to fill their quota of pages in the coming year. The electronic age is upon us with a vengeance. Mark Hopkins' log is wired for sound and Mark himself is now an infinitely reproducible and sometimes mercifully erasable tape activated by push buttons. The friendly, tweedy book salesman, so long a fixture in our academic offices and conventions, is being joined, and often overshadowed by the brisk, steely-eyed electronic systems sales engineer, exhuding sparks of expensive efficiency from every wired pore.

And yet, with it all, there is controversy. Let us give thanks to our tradition of critical examination in all matters of education that there is controversy. To be sure, a still too large portion of this controversy is dominated by the irreconcilable extremes - the pro-hardware versus the anti-hardware camp; the science of teaching versus the art of teaching advocates; those who decry the stultifying restraints of tradition versus those who point to the danger of bleeding to death from exposure to the cutting edge of progress. Neither position is fruitful; leaning too far backward or catapulting too far forward has the same basic result - falling down. Yet, in the case of audio-lingual aids to learning - the machine movement that began with the phonograph, continued through the disc recorder and the wire recorder, and culminated with the tape recorder and the language laboratory - we should by now have amassed sufficient experience to have mastered their proper application in the processes of language teaching and learning without being dominated by them either in uncritical advocacy or uncompromising opposition.

This discussion is an attempt, therefore, to assess the values and limitations of audio-lingual devices with some degree of objectivity within the practical context of the teaching-learning situation.

The audio-lingual recorder—reproducer that we know as the tape recorder has reached, even in relatively low-priced versions, a strikingly accurate reproduction of the human voice, endowed with an impressive degree of that quality known as "presence". It is possible, therefore, to record human speech and song with such fidelity that another's voice is clearly recognizable on a machine that is extremely simple to operate, reliable and consistent in performance, and of reasonable cost. Those of us who, only yesterday it seems, struggled with cumbersome disc recorders with their short-lived cutting styli tangling masses of inflammable acetate thread, and highly variable reproduction quality, can appreciate the ease of operation of even the meanest of present-day tape recorders.

In considering the use of the tape recorder as an aid to teaching and learning, however, we must analyze its capabilities a little further. As a reproducing and recording instrument, it is capable of reproducing and recording sound with a fidelity that encompasses the full range of sound frequency detectable by the human ear. It is, however, an exclusively aural instrument and, to the extent that sound has visual dimension, it is restricted to an incomplete version of sound. In the case of speech, it is particularly and crucially limited in that it excludes gesture, facial expression, and indeed physical presence. It reproduces speech in disembodied form, embodying thereby both pedagogical advantages and disadvantages - the advantage of concentration on the sound element alone, and the disadvantage of segmentation and incompleteness. (Sound film and television, by the way, extend the fidelity of reproduced speech to include the visual, but with the limitation that the visual

element is two-dimensional and usually monochromatic, and, when in color, is perceptively contrived.)

As an instrument of prerecorded sound the tape recorder does everything that a good phonograph can do, but its greatest advantage over the phonograph lies in its ability to record sound material and play it back immediately. It is this function of the tape recorder that has given birth to the language laboratory and that provides the electronic buttress of the so-called audio-lingual method of language teaching. But precisely what does it record and, even more important, what does it play back to the one who has recorded his own speech?

Stated simply, the machine plays back an individual's speech as others hear it, not as he hears himself. Stated technically, an individual hears himself as transmitted by an integrated combination of air conduction - externally from mouth to ear - and bone conduction, internally from voice mechanism to inner ear. He hears his recorded voice, however, as if it were produced by another person, through air conduction alone. He may be taught to recognize his own voice as played back by a tape recorder, but it will always sound significantly different from the voice he himself hears as he produces speech and communicates with others.

Here again we note a condition that has both pedagogical advantages and disadvantages. The individual hears himself as others hear him, and therefore he can perceive critically his effect on others. On the other hand, he can achieve little kinship with his own recorded voice, and therefore may find it difficult to transfer lessons learned in listening to himself as recorded to the actual problems of face-to-face communication, a situation in which he again is prevented from hearing himself as others hear him.

Communication is a two-way process, in which the initiative passes alternately from the initiator to the receptor, and in which stimulus not only breeds response, but the response itself acts as a stimulus for consequent response. In the recorder-learner situation, however, response is limited to whatever has been recorded, and in no case can the response itself act as a stimulus to the recorder. The recorder can only reproduce, it cannot produce; it can repeat, but it cannot react; it can communicate *to* but not *with*, and what it does communicate is only what has been fed into it. It is lacking, therefore, in the essential social element of communication, which requires the interplay of a minimum of two volitional agents.

With these characteristics in mind, we can consider the pedagogical uses of the tape recorder. What then, are the pedagogic functions it can perform well? Because it reproduces sound accurately, and because it can repeat itself as often as required, it lends itself spectacularly well to exercises in aural perception and lingual imitation. Because it has the ability to record and play back immediately the student's imitation of the model, it makes possible an objective comparison of model and imitative response by either an outside evaluator or the student himself.

It is therefore predominantly and pre-eminently a device for drill and objective evaluation. And, as with all devices and procedures for drill and evaluation, it is subject to many problems of use within the total teaching-learning complex, some of which are common to all drill and evaluation, and some of which are unique to the particular medium itself.

We all know that the purpose of drill is to provide the means for repetitive exercise which will culminate in proper language habits.

All repetitive exercise depends for its effectiveness (1) on its appropriateness for exercising the skill to be learned, (2) on the motivation and determination of the learner, and (3) on the ability of the learner to transfer what is learned in drill to practical use. The imitation exercises and pattern practice characteristic of machine utilization in language learning are therefore but a portion of the whole teaching-learning-application complex; and by the same token, the most elaborate and flexible language laboratory cannot be expected to do the whole job of language teaching. The trick is to build the machine into the whole process in such a way that it can be of maximum use.

Proper attention must be given to the preparation of the student for the specific exercises he is to use, to the monitoring of his progress, and above all to the application of what he has learned to the realistic requirements of communication with others. In some of these requirements the sound recorder extends measurably the scope and flexibility of drill: it is possible to individualize exercise material according to the needs of each student, and to maintain a continuous check on his progress, either through monitoring as the student works or through subsequent analysis of his tapes.

On the other hand, even with maximum motivation, the danger of fatigue must be reckoned with in any extension of exercise sessions beyond ten or at most fifteen minutes. A point of diminishing returns can set in very quickly, beyond which actual deterioration of student response may occur.

As to the problem of transfer to the actual communication situation, the recording is severely limited in scope. As we have seen, it can provide repetitive exercise within a controlled stimulus-response context, and can provide for the student an objective comparison of his own achievement with that of the models he imitates. Since he hears himself as others hear him, he can more readily detect the degree to which he falls short of the standard. On the other hand, since in communication he hears himself subjectively, and then only through the single dimension of sound, and since in communication he must act within an environment that is not controlled in any way as it was in the taped drill, transfer remains a problem as it does in any mode of formal language learning. No matter how flexible and sophisticated the audio-lingual devices may be, a major portion of formal language teaching must still concern itself with the setting of speech within the environments and conditions of practical communication. In sum, no matter how effective the work with the machine is, a major concern of the language teacher must still be the activities that come before and lead into the use of the recording device, and those activities that come after and may grow out of the listening and recording exercises.

Inevitably, the tape recorder has found itself built into an architectural system of booths, and individually and centrally controlled tape decks which we know as the language laboratory. We must recognize that as soon as major capital outlay and the permanent transformation of space is involved, the facilities themselves will tend to add their cement to the cake of custom and bring the influence of their visible expense to bear on the conduct of instruction. It is vital, therefore, that we recognize the functions that we expect to have performed within its precincts and recognize both their values and limitations.

The functions of a formalized language laboratory are basically two -- the library, or self-instruction, function; and the classroom, or teacher-guided, function. In the former, the student uses the laboratory as he would a library -- he borrows assigned tapes, takes them to a booth, and works with them individually much as he would borrow books from the reference desk and work with them at the study tables. In the latter, the laboratory is built into the instruction itself, with the teacher in control, guiding the use of the recorders, monitoring them when necessary through a central control panel and communication system, and communicating with individuals or groups of students as the need arises.

The two functions are of course not mutually incompatible, but they are probably best achieved in separate facilities, with a language laboratory reserved for self-study and individual exercises, and a series of "electronic classrooms" used for guided language instruction. The self-instructive language laboratory, as long as it is looked upon as a supplement to instruction in the manner of a library workroom, is the least vulnerable to suppression of creativity in a system of language teaching, but the electronic classroom must be designed and used most carefully, lest its machinery act as a determinant of, rather than an aid to, language learning.

It is therefore essential that the audio-lingual machinery to be used in the classroom be designed for utmost flexibility, so that all-class, small-group, and individual activities may be possible with a minimum of button pushing and dial twisting. And it should be possible to communicate with students in groups and individually not only via microphone and programmed tape, but in the old-fashioned way of air-conducted voice. In recognition of the fact that communication is a social affair, it should be possible, in addition, for students and teachers to break out of the confinement of sound-treated booths and meet each other and the teacher face to face. An electronic classroom is best conceived, therefore, in a manner which will allow the walls of booths to be folded down over recording mechanism, microphone and tape, or even removed entirely, so that those aspects of language learning which are not reducible to taped exercise can receive their proper attention.

I live in fear that someone will seek to overcome some of the limitations of audio-lingual aids in their present development by further mechanical means. The sound recording system does not embody the visual elements of speech - facial expression, gesture, and other bodily movement? Very well, let us equip each language laboratory with a self-contained closed-circuit television system complete with vidicon camera and monitor, so that the student will not only be able to hear himself as others hear him, but see himself as others see him as he speaks. And in the ultimate development, provide for transmission of sound and associated image to a kinescope or video-tape recorder so that a record may be available for later evaluation.

Does this sound far-fetched? In the institution I represent, we are doing something quite similar in an associated field - we are kinescoping student teachers as they teach and our supervisors work with them as they hear and watch a recording of the student teacher having taught. We believe this method has great possibilities in assisting the development of skill in any of the performing arts - and teaching is obviously one of them. Yet we find ourselves in constant danger of allowing our fabulously expensive equipment to determine the educational goals and methods, rather than to have them act properly as means and aids to our goals. We are in constant danger of being more preoccupied with making use of our equipment than with furthering the development of our students. Tragically enough, the greater the usefulness of the machine, and certainly the greater its expense, the more are we in danger of being dominated by it. In consequence, we are determined to pay as much attention to discovering the limitations of our machines as we are in developing their use.

Thus it is with audio-lingual aids to language learning. They can do much to make our work as teachers of language more effective. They will not make the task easier, however, nor will they make it cheaper, nor will they do it all.

Appendix G

DEFINITIONS FOR A SYSTEM APPROACH TO PROVIDING LEARNING RESOURCES

by

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Eastman Kodak Company

Words are tools for analytical thinking. Their connotations color our judgments in these thinking operations and so we must select them with care.

In talking about systems for supporting education by means of resources and services it is necessary to talk about the many media and operations in terms which are general, terms which are not limited in their connotation to any one medium. Rather than develop brand-new terms, I am proposing that we adopt the terminology of the folks in the computer and information-processing field and extend the meanings to the field of instructional practices. What follows is an attempt to do this. The following words will be taken up:

Display	(noun and verb)
Store	(verb) and Storage (noun)
Retrieve	(verb and Retrieval (noun)
Search	(noun and verb)
Read-out	(noun and verb)

Display

During a program of instruction the learner is subjected to the presentation of sensory data. In some cases this is under direct control by the instructor; in other cases an individual appears to do this through one of the media (motion picture, television, sound recordings, a book, etc.). It also occurs as an event initiated by the learner (reading, looking at pictures and graphics, listening to recorded sound).

The point is that many media channels are involved and it occurs under many conditions. The general term used for the operation is "Display."

The verb form "to display" implies that someone engages in a discrete act that results in the presentation of an organized pattern of sensory data. This ranges from displaying to oneself (as in reading a book, picking up a picture to look at it), to a teacher hanging a map on the wall or playing a recording, or a projectionist operating a device to show a sound motion picture on the screen. Notice that it implies a contrived situation in the sense used here. Making a statement and holding up an object to view are within this meaning.

"Display" is also used as a noun. Here it refers to the pattern of energy that has been generated. It can be evaluated in terms of the types of discrimination it permits, the maximum amount of information per field, types of sense organs stimulated, feasible size as it influences portability, storage requirements, number of observers that can be served at one time, etc. Note that the "display" is created as an energy pattern; with some media this pattern can be stored for later use, it may be ephemeral, and it may not necessarily be stored in a physical form similar to that used for read-out. Thus we can refer to the display as the entity that exists before the act of read-out as well as in that state in which it appeals to the senses.

The display can be designed to appeal to any of the senses, singly or in combination. While the eye and ear channels predominate in learning situations, the other senses should not be neglected (examples -- sensing textures in fabrics, identification by odor in cooking).

"Store (Storage")

Here we are referring to the existence of an interval between the creation of the message as a unit of organized data or information and its presentation to the senses of the individual. In direct speech or a live demonstration the delay is zero. However, both events can be stored for delayed read-out by appropriate methods. The information loss characteristic of the storage system is a factor to be considered here. Space occupied by the stored information is another significant factor.

"Retrieve (Retrieval")

When a message is stored, it is obvious that certain operations must be carried out to ready it for being displayed. These operations constitute the act of retrieval. This act includes such functions as initiating the retrieval and transportation of the message from the point of storage to the point of display.

"Search"

This is the operation of determining whether certain information is in storage, the manner in which it is organized, and where it is located. As information is stored in a wide diversity of forms, the problem of search becomes increasingly complex. Another complicating factor is the need to include in the search procedure such considerations as the character of the audience for which the message is designed and the task it proposes to do.

"Read-out"

This is the operation of sensing and/or perceiving the display. It is used either as a noun or a verb. Read-out can be an activity of an individual or a group. In the case of the group it can be simultaneous or distributed in time. Another variable is the spatial distribution of the group (all together or scattered in small groups in many locations). Task involvement during read-out is another consideration.

Note:

Analysis under these categories will permit a comparison of media with regard to certain merits. In some instances this can involve extremely precise technical data and provide an accurate foundation for evaluating the relative merits of systems. For example, here is a brief statement with respect to characteristics of the photographic process with respect to its application to communication systems. This material was extracted from an article by Raiefe C. Tarkington of the Research Laboratories of the Eastman Kodak Company "Photography Rediscovered", Signal, Vol. XIII, pp. 73-77 and 88, May 1959).

Characteristics of photography that affect its usefulness in communication applications are:

1. Reliability
2. High sensitivity
3. Sensitivity — image-quality ratio (linearity)
4. Weight — volume — information quantity ratio
5. Spectral sensitivity
6. Intensity summing ability
7. Versatility
8. Simplicity of operation
9. Amplification factor ($10^8 - 10^{10}$)
10. Amplification delay characteristics

"Here are some data on the weight - volume - information quantity relationship in the case of an aerial photograph.

"The film used resolves in excess of 350 lines per millimeter and can be exposed in full sunlight at 1/400 second with an f/5.6 aperture.

"Using a very conservative figure of 3.5 microns as a reasonable size that can be distinctly recorded, and assuming a conservative number, 8, of shades of densities between density limits of 0.25 to 2.5, with this film one can record 150 million bits of information per square inch. (This total number of bits was calculated on the basis that the 8 density levels represent only 3 bits of information where a bit is defined as $\log_2 N$.) The area of the film which can be exposed in each 1/100 second is limited only by the size and efficiency of the mechanical and optical equipment available, which is, of course, the limit on the total number of bits of information that can be recorded by a single exposure. However, take for example, not the largest or the smallest size equipment for illustration, but one that will expose a 4½ by 4½-inch area at a time on a roll of film. A 50-foot roll of film, 5 inches wide, can easily contain 120 4½ by 4½-inch pictures which represent at least 3.6×10^{11} bits of information. (To transmit the 3.6×10^{11} bits of information from one point to another on a 10-megacycle bandwidth would require at least 5 hours.) If necessary, this length of film could be exposed in less than 2 minutes."

It is apparent that similar analytical procedures can be used for determining the performance requirements of various display systems to meet the requirements of visibility and legibility of various read-out conditions (group size, environment conditions).

Appendix H

APPARATUS ANALYSIS

(Conference Work Form)

1. **Kind of Apparatus** ______________________________ 2. **Code #** ______

3. **Message Characteristics:**

   a) Aural ____; b) Visual ____; c) Visual (Printed) ____; d) Other (state) ____

4. **Sensory Appeals:**

   a) Eye (black & white) ____; b) Eye (color) ____; c) Ear ____;

   d) Touch ____; e) Taste ____; f) Smell ____

5. **Types of Symbols:**

   a) Print ____; b) Speech/sound ____; c) Still Pictorial Image ____;

   d) Moving Pictorial Image ____; e) Other (state) ________________

6. **Degrees of Message Permanency:**

   a) Very Ephemeral ____; b) Ephemeral ____; c) Permanent ____;

   d) Archival ____

7. **Psychological Potential:**

   7.1 **Motivation** -

   a) Very much ____; b) Some ____; c) Little ____; d) None ____;

   e) Minus ____

   7.2 **Creativity and Imagination**

   a) Very much ____; b) Some ____; c) Little ____;

   d) None ____; e) Minus ____

7.3 Reinforcement -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.4 Information Giving -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.5 Repetition and/or practice -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) minus ____

7.6 Insight and Understanding -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.7 Attitudes -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.8 Independence (self-reliance) -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus

7.9 Critical Thinking -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.91 Skill (Physical or Manual) -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

7.92 Skill (Mental) -

a) Very much ____; b) Some ____ c) Little ____;

d) None ____; e) Minus ____

7.93 Emotion -

a) Very much ____; b) Some ____; c) Little ____;

d) None ____; e) Minus ____

8. Physical Availability:

a) Requires no transmission
or reproduction apparatus ____

b) Requires apparatus of
transmission or reproduction ____

c) Very portable ____; Portable ____; Nonportable ____

d) Requires little or no expertise ____

e) Requires some expertise ____

f) Requires considerable expertise ____

g) Requires great expertise ____

(For example, to read a book requires some or great expertise).

9. Audience Characteristics:

a) Can be used by individual alone ____

b) Can be used by several individuals ____

c) Can be used by either individual or group ____

d) Can be used by group ____

e) Can be used by small group only ____

f) Can be used by large group ____

g) Can be used by mass audience ____

10. Time and Space (location of origin and read-out, time between origin and read-out):

a) Instantaneous ____; Slight time lag ____

b) Short delay ____; Delayed transmission ____

c) User can select time ____

d) Display at point of message origin ___

e) Display close to point of message origin ___

f) Display at some distance from message origin ___

g) Display at great distance from message origin ___

11. Comparative Ease of Message Preparation:

a) Very easy ___; Easy ___; Difficult ___; Very difficult ___

b) Message cannot be edited ___; Message hard to edit ___

c) Message easily edited ___; Message very easily edited ___

d) Message cannot be copied ___; Message can be copied ___

e) Message easily copied ___; Message very easily copied ___

12. Degree of Availability to Student:

a) Available to student on demand in school ___

b) Available to student out of school on demand ___

c) Available to student in school only under teacher's direction ___

13. Teaching - Learning Systems Compatibility (TLSC):

a) Extremely compatible ___; Compatible ___

b) Somewhat compatible ___; Incompatible ___

c) Potentially compatible if redesigned ___

d) Fundamentally incompatible ___

14. Economic Availability Factors to Consider:

14.1 Basic Capital Investment (per unit of apparatus or material) $_____

14.2 Annual Cost (total): $ __________

a) Depreciation $ __________

b) Power consumption $ _________

c) Service costs (accessories and scheduling) $ _________

d) Service costs (operational) $ ________

e) Repairs and maintenance $ ________

f) Expendable items (lamps, tubes, etc.) $ ________

14.3 Instruction Costs:

a) Per pupil per single unit of use $ ________

b) Per class per annum $________

c) Per curriculum unit per annum
(unit for entire school system) $ ________

d) Hourly, per individual student $ ________

e) Hourly, per group $ ________

PART EIGHT

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